ENERGY AWARE PLANNING GUIDE

CONSULTANT REPORT

Prepared By
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with the Local Government Commission,
Calthorpe Associates, and
Davis Energy Group

Prepared for
CALIFORNIA
ENERGY COMMISSION

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DISCLAIMER

ENERGY AWARE PLANNING GUIDE

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ENERGY AWARE PLANNING GUIDE

ABSTRACT

The Energy Aware Planning Guide, developed by the California Energy Commission in 1993 and updated in 2009, is a comprehensive resource for local governments seeking to reduce energy use, improve energy efficiency and increase usage of renewable energy across all sectors. Wiser use of energy resources can lead to cost savings for local governments, residents, and businesses; reinvestment in the local economy; improved quality of life and public health; increased compliance with state and Federal goals; and a more secure future. Additionally, strategies to reduce energy consumption promote progress towards aggressive greenhouse gas reduction goals laid out in AB 32, California's Global Warming Solutions Act. The Energy Aware Planning Guide presents a menu of strategies and best management practices to help local governments improve energy efficiency, reduce energy consumption through transportation and land use and enhance renewable sources of energy. Strategies explored include: transportation and land use changes; optimizing water use; building improvements; and other strategies. Each strategy section contains general plan language ideas; implementation ideas; case studies; and resources. The Energy Aware Planning Guide also contains supporting information and references to help local governments organize strategies into an Energy Action Plan and estimate the likely energy efficiency and greenhouse gas reduction impacts of their strategies.

Keywords: energy efficiency, transit-oriented development, smart growth, best management practices, renewables, local government, transportation, land use, land use planning, buildings, greenhouse gases, generation, adaptation planning, policy, climate change.

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ENERGY AWARE PLANNINGGUIDE
EXECUTIVE SUMMARY

Introduction

The Energy Aware Planning Guide, developed by the California Energy Commission in 1993 and updated in 2009, is a comprehensive resource for local governments seeking to reduce energy consumption and increase usage of renewable energy across all sectors. Wiser use of energy resources can lead to cost savings for local governments, residents, and businesses; reinvestment in the local economy; improved quality of life and public health; increased compliance with state and Federal goals; and a more secure future. Additionally, energy efficiency strategies promote progress towards aggressive greenhouse gas reduction goals laid out in AB 32, California's Global Warming Solutions Act. The Energy Aware Planning Guide presents a menu of strategies and best management practices to help local governments reduce energy use and enhance renewable sources of energy, including transportation and land use strategies; water use strategies; building strategies; and community energy strategies. Each strategy section contains general plan language ideas; implementation ideas; case studies; and resources. The guide also contains supporting information and references to help local governments organize strategies into an Energy Action Plan and estimate the likely energy and greenhouse gas reduction impacts.

Purpose

The purpose of the Energy Aware Planning Guide is to provide technical information to local governments seeking to improve energy efficiency, reduce energy use and greenhouse gas emissions, and enhance renewable sources of energy. The guide is organized into the following sections:

» **Section I –** Introduction

» **Section II –** Create an Energy Action Plan presents a framework for inventorying sources and uses of energy at the municipal level, and identifying opportunity areas where energy production or use could be managed more wisely. Included are worksheets to help municipalities inventory energy use and reduce greenhouse gas emissions.

» **Section III –** Meeting California's Climate Change Challenge summarizes recent state requirements to reduce greenhouse gas emissions as stipulated in the Global Warming Solutions Act (AB 32), the Sustainable Communities and Climate Protection Act (SB 375), and the California Environmental Quality Act. It also includes a guide to preparing community adaptation plans to assess and mitigate municipal greenhouse gas emissions.

» **Section IV –** Integrated Planning describes the benefits of coordinating local and regional planning efforts, provides examples of successful integrated planning experiences, and lists resources for integrating planning practices.

» **Section V –** Energy Aware Planning Opportunities presents a detailed inventory of strategies to reduce energy use in land use, transportation, buildings, water use, and other community efforts. Each idea in the Guide is called a Planning Opportunity Strategy and includes sample General Plan language; implementation possibilities; energy, environmental and economic impacts; and notable cases and resources from California and elsewhere. At the end of each strategy section, a list of related strategies is provided.

» Appendix A includes metrics useful for quantifying the energy and greenhouse gas reduction impacts of the energy aware strategies.

» Appendix B provides the Ahwahnee Principles for planning more livable communities. The Ahwahnee principles are a simple, concise set of principles intended to guide local governments in the development of sustainable, resource-efficient communities.

GLOSSARY

ABAG	Association of Bay Area Governments
AASHTO	American Association of State Highway and Transportation Officials
AC Transit	Alameda-Contra Costa Transit District
APA	American Planning Association
APS	Alternative Planning Strategy
ARB	Air Resources Board
ASCE	American Society of Civil Engineers
ATCS	Adaptive Traffic Control System
ATMS	Advanced Transportation Management System
ATN	Anaheim Transportation Network
AVR	Average vehicle ridership
BART	Bay Area Rapid Transit
C&D	Construction and demolition
CALBO	California Building Officials
CalCERTS	California Certified Energy Rating and Testing Services
Caltrans	California Department of Transportation
CAS	Climate Adaptation Strategy
CBD	Central Business District
CCAA	California Clean Air Act
CCAN	California Climate Action Network
CCROPP	Central California Regional Obesity Prevention Program
CCSE	California Center for Sustainable Energy
CC&Rs	Covenants, conditions and restrictions
CEQA	California Environmental Quality Act
CHEERS	California Home Energy Efficiency Rating System
CHP	California Highway Patrol
CIWMB	California Integrated Waste Management Board
CMA	Congestion Management Agency
CMAQ	Congestion Mitigation and Air Quality Improvement Program
CMAS	California Multiple Awards Schedule
CMP	Congestion Management Programs
CMS	Changeable message sign
CO2	Carbon dioxide
CO2e	Carbon dioxide equivalent
COG	Council of Governments
CPUC	California Public Utilities Commission
CSI	California Solar Initiative
CUFR	Center for Urban Forest Research (USDA)
DEER	Database for Energy Efficient Resources
DER	Distributed energy resources
DOE	Department of Energy
DOT	Department of Transportation
DSIRE	Database of State Incentives for Renewable Energy
DWR	Department of Water Resources
EIR	Environmental impact report
EIS	Environmental Impact Statement
EMS	Emergency management system
EPA	Environmental Protection Agency
ETC	Employee Transportation Coordinator
FETSIM	Fuel Efficient Traffic Signal Management
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GHG	Greenhouse gas
GPS	Global Positioning System
GRH	Guaranteed ride home
HC	Hydrocarbon
HERS	Home Energy Rating System
HFC	Hydrofluorocarbon
HOV	High Occupancy Vehicle
HUD	Department of Housing and Urban Development
HVAC	Heating, ventilating and air conditioning
IPCC	Intergovernmental Panel on Climate Change
IRWM	Integrated Regional Water and Flood Management
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
KCDPH	Kern County Department of Public Health
kW	Kilowatt
kWh	Kilowatt hours
LA Metro	Los Angeles County Metropolitan Transportation Authority

LACSD	Los Angeles County Sanitation District
LADWP	Los Angeles Department of Water and Power
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design
LOS	Level of service
LTL	Less than truckload
MAX	Metropolitan Area Express (Portland, Oregon)
MMBtu	1000 BTU (British Thermal Units)
MMT	Million metric tons
MPG	Miles per gallon
MPO	Metropolitan Planning Organization
MTC	Metric tons
MTC	Metropolitan Transportation Commission
MUTCD	Manual on Uniform Traffic Control Devices
MW	Megawatts
MWh	Megawatt hours
NCHRP	National Cooperative Highway Research Program
NEG	Net excess generation
NOx	Nitrous oxide
NSHP	New Solar Home Partnership (Energy Commission)
OPR	Office of Planning and Research
PDC	Portland Development Commission
PFC	Perfluorated Carbon
PG&E	Pacific Gas and Electric
PIER	Public Interest Energy Research Program
PLACE3S	Planning for Community Energy Economic and Environmental Sustainability
PM	Particulate matter
PM10	Particulate matter of 10 microns in diameter or smaller
PM2.5	Particulate matter less than 2.5 microns in diameter
PMD	Parking management district
PPA	Power Purchase Agreement
psi	Pounds per square inch
PUD	Pick-up and delivery
PV	Photovoltaic
RHNA	Regional Housing Needs Assessment
RMDZ	Recycled Market Development Zone (CIWMB)
RPS	Renewable Portfolio Standard
RSTP	Regional Signal Timing Program
RTIP	Regional Transportation Improvement Program
RTP	Regional Transportation Plan
SACOG	Sacramento Area Council of Governments
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
SCAQMD	Southern California Air Quality Management District
SCE	Southern California Edison
SCS	Sustainable Communities Strategy
SDG&E	San Diego Gas and Electric
SEGA	Southeast Growth Area (Fresno)
SGIP	Self-Generation Incentive Program (Public Utilities Commission)
SIP	State Implementation Plan
SLOCOG	San Luis Obispo Council of Governments
SOV	Single-occupant vehicle
SOx	Sulfur oxide
SR2S	Safe Routes to School Program
STIP	Surface Transportation Improvement Program
SUV	Sport utility vehicle
TCM	Transportation control measure
TCRP	Transit Cooperative Research Program
TDM	Transportation demand management
TDR	Transfer of development rights
TDV	Time dependent valuation (of energy)
TEA 21	Transportation Equity Act for the 21st Century
TEU	Twenty-foot equivalent units
TIF	Tax Increment Financing
TMA	Transportation Management Association
TND	Traditional Neighborhood Development
TOD	Transit Oriented Development
TRO	Trip Reduction Ordinance
UC	University of California
UCC	Urban consolidation center
USDA	United States Department of Agriculture
USDG	Urban Street Design Guidelines
VMT	Vehicle miles traveled
VOC	Volatile organic compound
VTA	Santa Clara Valley Transit Authority
WARM	Waste Reduction Model (U.S. EPA)
Wp	Peak watt

SECTION I

INTRODUCTION

ENERGY AWARE PLANNING GUIDE

INTRODUCTION

The Energy Aware Planning Guide contains strategies to help municipal governments use energy resources as wisely as possible. Wise energy use benefits municipal governments in many ways:

» **Reduced costs of operations.** Municipal governments use energy to operate buildings and municipal fleets and to maintain public spaces such as roads and parks. Reducing the energy requirements of these activities can result in direct cost-savings for municipal governments, although some up-front investment may be required. For example, Contra Costa County began saving $300,000 per year after implementing energy efficiency retrofits to eight buildings that reduced the buildings energy use by an average of 28 percent.[1]

» **Reduced costs for residents and businesses.** Municipal governments have many tools for reducing the energy used by local residents and businesses and saving them money along the way. For example, by building denser development patterns, municipal governments may reduce the amount of electricity required to power homes and reduce the amount of driving necessary to get around.

» **Reinvestment in the local economy.** Residents and business owners can help stimulate the local economy if they spend energy cost savings in their area. Additionally, some renewable energy and energy efficiency programs require skilled workers and investments that could help to spur local innovation and associated economic growth.

» **Improved quality of life and public health**. Many energy efficiency strategies have the added benefit of improving local quality of life and public health. For example, strategies to encourage walking and bicycling can reduce harmful air pollutant emissions associated with driving and contribute to more healthful levels of physical activity. One study found that mixed-use urban environments are associated with lower levels of obesity.[2]

» **Compliance with state and Federal laws and goals.** Many of the strategies in the energy aware guide support municipal government compliance with state and Federal laws, such as the California Clean Air Act and the Congestion Mitigation Program. They also support achievement of the greenhouse gas reduction goals laid out in the Global Warming Solutions Act (AB 32) and the Sustainable Communities and Climate Protection Act (SB 375).

» **A more secure future.** Energy and water (which requires energy to treat and pump) are essential, but supplies may be uncertain due to service disruptions, price volatility, and climate change, which is expected to cause more severe weather events and droughts. Diversification of the local energy supply and more investment in energy and water efficiency measures can help reduce the likelihood of disruptions and soften their impact if they occur. For example, investments in mass transit facilities provide residents and workers alternatives to driving, which may reduce the impact of spikes in the price of gasoline.

Inside the Guide

The Energy-Aware Planning Guide is organized into the following sections:

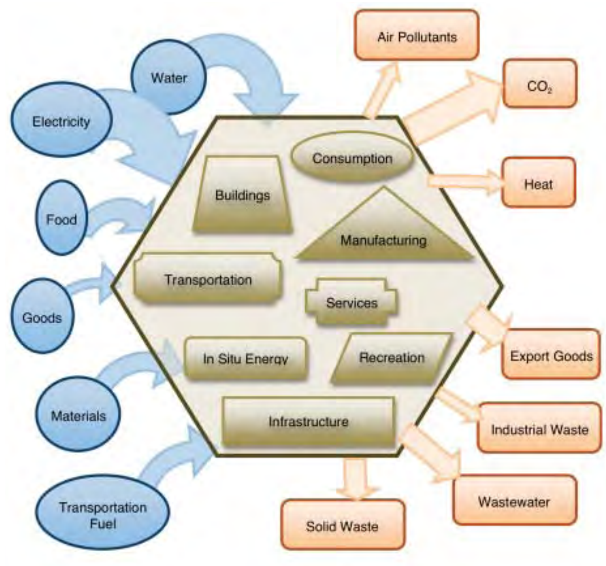
» **Section II – Create an Energy Action Plan** presents a framework for inventorying sources and uses of energy in the community and identifying opportunity areas where energy production or use could be managed more wisely.

» **Section III – Meeting California's Climate Change Challenge** summarizes recent state requirements to reduce greenhouse gas emissions as stipulated in the Global Warming Solutions Act (AB 32), the Sustainable Communities and Climate Protection Act (SB 375), and the California Environmental Quality Act. It also includes a guide to preparing community adaptation plans to assess and mitigate municipal greenhouse gas emissions.

» **Section IV – Integrated Planning** describes the benefits of coordinating local and regional planning efforts, provides examples of successful integrated planning experiences, and lists resources for integrating planning practices.

» **Section V – Energy Aware Planning Opportunities** presents a detailed inventory of strategies to reduce energy use in land use, transportation, buildings, water use, and other community efforts. Each idea in the Guide is called a Planning Opportunity Strategy and includes sample General Plan language; implementation possibilities; energy, environmental and economic impacts; and notable cases and resources from California and elsewhere. At the end of each strategy section, a list of related strategies is provided. This list is important because the greatest benefits can be realized when an energy issue is "attacked" from all angles.

Community Energy Inputs, Uses, and Outputs



Each community is an organism with inputs, uses of inputs, and outputs. The strategies in the Energy Aware Planning Guide help communities use inputs more efficiently and produce fewer harmful or wasteful outputs. In the best cases, they can help communities create a "closed loop," where outputs become inputs. For example, wastewater can be recycled and used as an input to meet the community's needs. Gas collected from waste in landfills can be used to power buildings and residences. Source: Developed for the Energy Commission by Stephanie Pincetl and Paul Bunje of the UCLA Institiute of the Environment.

» **Appendix A** includes metrics useful for quantifying the energy and greenhouse gas reduction impacts of the energy aware strategies. **Appendix B** provides the Ahwahnee Principles for planning more livable communities. The Ahwahnee principles are a simple, concise set of principles intended to guide local governments in the development of sustainable, resource-efficient communities. An excerpt from the original Ahwahnee principles for Resource Efficient Communities are listed in the box on the right. Complete principles for resource efficiency, water, and climate change are included in the Appendix.

The Ahwahnee Principles for Resource-Efficient Communities: An Excerpt

Developed in 1991 by the Local Government Commission and partners.

- All planning should be in the form of complete and integrated communities containing housing, shops, work places, schools, parks and civic facilities essential to the daily life of the residents.
- Community size should be designed so that housing, jobs, daily needs and other activities are within easy walking distance of each other.
- As many activities as possible should be located within easy walking distance of transit stops.
- A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.
- Businesses within the community should provide a range of job types for the community's residents.
- The location and character of the community should be consistent with a larger transit network.
- The community should have a center focus that combines commercial, civic, cultural and recreational uses.
- The community should contain an ample supply of specialized open space in the form of squares, greens and parks whose frequent use is encouraged through placement and design.
- Public spaces should be designed to encourage the attention and presence of people at all hours of the day and night.
- Each community or cluster of communities should have a well-defined edge, such as agricultural greenbelts or wildlife corridors, permanently protected from development.
- Streets, pedestrian paths and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees and lighting; and by discouraging high speed traffic.
- Wherever possible, the natural terrain, drainage and vegetation of the community should be preserved with superior examples contained within parks or greenbelts.
- The community design should help conserve resources and minimize waste.
- Communities should provide for the efficient use of water through the use of natural drainage, drought tolerant landscaping and recycling.
- The street orientation, the placement of buildings and the use of shading should contribute to the energy efficiency of the community.

Getting Started

First, use the methodology in Section II to get a handle on the nature and scope of energy use in your jurisdiction. Consider how changes in energy use patterns would benefit your local economy and help you comply with Federal and state mandates now in place and over your planning horizon, including the climate change mandates described in Section III. Ask questions. For example, what economic and environmental benefits would be gained by reducing transportation fuel use by 10 percent by 2030? What environmental issues overlap with energy planning opportunities? Can economic benefit assessment via energy planning be a component of your jurisdiction's land use planning, transportation planning or environmental alternatives analysis?

Then, shop for ideas in Section V. Technical references and case studies can be used to gather more detailed information on ideas with the greatest potential for addressing your set of energy issues. Prepare a list of the Planning Opportunity Strategies that seem most suited to your jurisdiction. Group the ideas into sets and put the sets in order of priority. Roughly estimate the costs and benefits of taking action, and seek outside involvement in identifying the highest priority strategies. Particularly engage interested agencies (e.g., water agencies, transit agencies) and regional governments (see Section IV for a description of the benefits of coordinating local and regional planning).

Consider how to move forward with the highest priority actions. Is your General Plan soon undergoing a major update? Should an Energy Element or an Air Quality Element be prepared? Can the strategies be included in the Sustainable Communities Strategy being prepared by your region? At the same time, consider how the strategies will be funded and who will take responsibility for implementation over what time period.

The 1993 Energy Aware Planning Guide

This guidebook is an updated version of the original Energy Aware Planning Guide, produced in 1993 by the Energy Commission. The guidebook was updated to reflect the latest strategies for reducing energy use and to incorporate a new emphasis on reducing greenhouse gas impacts as well.

All the strategies in the guidebook were updated with new general plan language ideas, implementation ideas, and case studies, and many new sections were added, including the Energy and Greenhouse Gas Estimates; the sections on California's Climate Change Challenge, Adaptation Planning, and Fully Integrated Planning; the Community Energy Strategies section, and other sections.

Endnotes

1. CEC. 2006. California Energy Commission Partnership Program. Sacramento: California Energy Commission. http://www.energy.ca.gov/efficiency/partnership.

2. Frank, L., M. Andresen, T. Schmidt TL. 2004. "Obesity Relationships with Community Design, Physical Activity, and Time Spent In Cars." American Journal of Preventative Medicine 27:87--96.

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SECTION II

CREATE AN ENERGY ACTION PLAN

ENERGY AWARE PLANNING GUIDE

STEPS TO CREATING AN ENERGY ACTION PLAN

Energy and greenhouse gas reductions don't happen on their own. Achieving reductions requires identification of effective strategies and best management practices; assignment of responsibility for implementation; and goal tracking – in other words, a plan. Energy Action Plans are a critical tool for ensuring that energy and greenhouse gas reduction strategies are implemented and that goals are met. This section provides a high-level of overview of the basic steps required to create an energy action plan.

Steps to Create an Energy Action Plan

1. Organize a committee of people to oversee plan development.

2. Inventory current energy sources.

3. Inventory uses of energy and evaluate future needs.

4. Inventory energy emissions and evaluate future trends.

5. Set preliminary goals for energy and greenhouse gas reduction.

6. Identify strategies to reduce use of non-renewable sources of energy.

7. Identify strategies to increase use of renewable and alternative forms of energy.

8. Summarize and analyze findings.

9. Finalize action steps, goals, and monitoring Measures.

10. Write and adopt the plan.

A detailed description of each step is provided on the following pages.

Step 1: Organize

The first step in plan development is to organize the right group of people to oversee the process. Including the right people from a diversity of backgrounds will ensure that:

» The plan considers all possible opportunities to reduce energy use and improve energy efficiency.

» The strategies in the plan are realistic given technical, funding, and political constraints.

Additionally, the committee can help in the assignment of responsibility for implementation and tracking of the strategies in the plan. The plan will be most effective if it is clear who is responsible for implementing the strategies within a given timeframe.

Step 2: Inventory Current Energy Sources

The sources of a community's energy supplies are an important baseline for energy planning because of local dependence on the adequacy and reliability of those sources and the economic and environmental consequences of dependence.

A community level understanding of energy sources can be assembled by answering the following questions:

» How much energy is the community using and from what sources? Answering this question requires carefully defining the boundaries of the community, which in some cases may stretch beyond defined political boundaries.

» To what extent are energy supplies produced locally versus imported from outside the community? Production of energy locally can help keep more dollars in the local economy, and can help reduce uncertainty associated with fluctuations in imported energy supplies.

California is fortunate to have one of the world's most diverse set of energy sources (see "California's Energy Sources 2006"). This diversity has helped make California less vulnerable to disruptions in energy supply, and has reduced the environmental impact of energy production compared to many states which rely more heavily on fossil fuels.

How are Most Energy and Climate Action Plans Related?

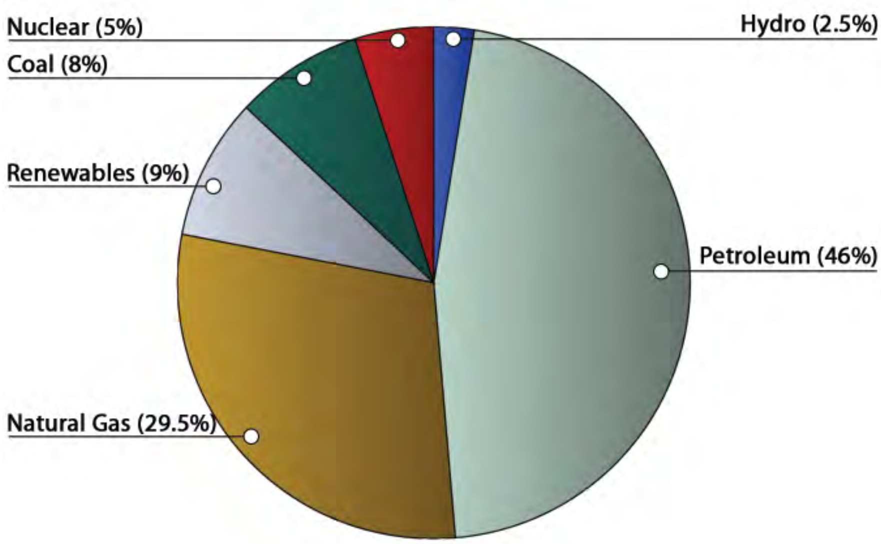
Energy use and climate change are very closely related, since greenhouse gases are produced when fossil fuel energy is consumed.

Although communities could prepare separate action plans to address energy and climate issues, the action plans will likely contain similar inventories and strategies. Energy action plans might focus more on the importance of energy security and diversity, and might include information on multiple types of emissions (beyond greenhouse gases). Climate Action Plans focus only on addressing greenhouse gases and their impacts.

It may be more cost-effective for communities to create a single document that addresses both energy use and climate change. It could also address strategies for adapting to climate change (see Section III: Adaptation Planning). Many California cities, such as San Francisco, Sacramento, Berkeley, San Diego, Los Angeles, and others have recently drafted climate action plans.

For large cities or regions, it may be appropriate to create individual plans for different sectors. For example, SB 375 requires regions to create a plan for addressing greenhouse gas emissions from the transportation sector (the Sustainable Communities Strategy).

California's Energy Sources 2006



- To what extent is energy produced from renewable and nonrenewable sources? Greater use of renewable resources reduces many of the environmental and climate change impacts associated with energy production.

- How diverse is the mix of supplies, and is there over-reliance on any particular source? Diversity in energy supplies can help protect against unexpected interruptions in supply from any single source. Ideally no more than about one–third of the energy supplies should be provided by any single source.

Each source of local energy should be characterized according to its means of production and distribution, quality and other important attributes (e.g. co-products, consistency, reliability), quantities supplied annually, and current customer rates. The inventory worksheets at the conclusion of this section list some of the main supply questions and provide sources of assistance for completing a local supply inventory.

Step 3: Inventory Current Usage and Evaluate Future Needs

Having identified where a community's energy comes from and what it costs, the next step is to determine how that energy is used. This is done by dividing the community into major end-use sectors and surveying consumption characteristics in each sector. On a statewide level, over 40 percent of California's energy consumption occurs in the transportation sector, followed by industrial use that accounts for about one-fifth of statewide usage (see "California Energy Usage by Sector 2006" chart). Water usage is embedded in each of these sectors. In its 2005 report, California's Energy-Water Relationship, the Energy Commission estimated that water usage accounts for 19 percent of all electricity consumed in the state and 30 percent of non power plant–related natural gas use. Distribution and disposal of solid waste is another major user of energy, and landfills produce direct emissions of potent greenhouse gases such as methane.

On a community level, key end-use considerations include:

- Which local sectors are the largest consumers now, and what are apparent trends?

- How do local energy consumption patterns compare with usage in similar communities?

- What are the costs of energy usage, and how do these affect the local economy?

- What are the adverse environmental effects associated with different sources of energy?

Each end-use sector should be surveyed according to characteristics that influence energy consumption (such as the type, age and condition of housing); fuels and types of heating and cooling equipment prevalent in the sector; and estimates of total annual energy use for the sector. The inventory worksheets accompanying this section list questions for characterizing energy consumption and provide potential sources of data. Completion of the end-use surveys will support a sound understanding of local energy supplies and demand.

In addition to current energy usage, local officials should consider forecasts of future energy consumption. Communities can calculate present per capita consumption based on existing usage and apply population growth forecasts to arrive at an estimate of future energy use. The incremental difference between current and projected demands raises a key planning issue: what is the most cost-effective and environmentally sound method of meeting future energy demands?

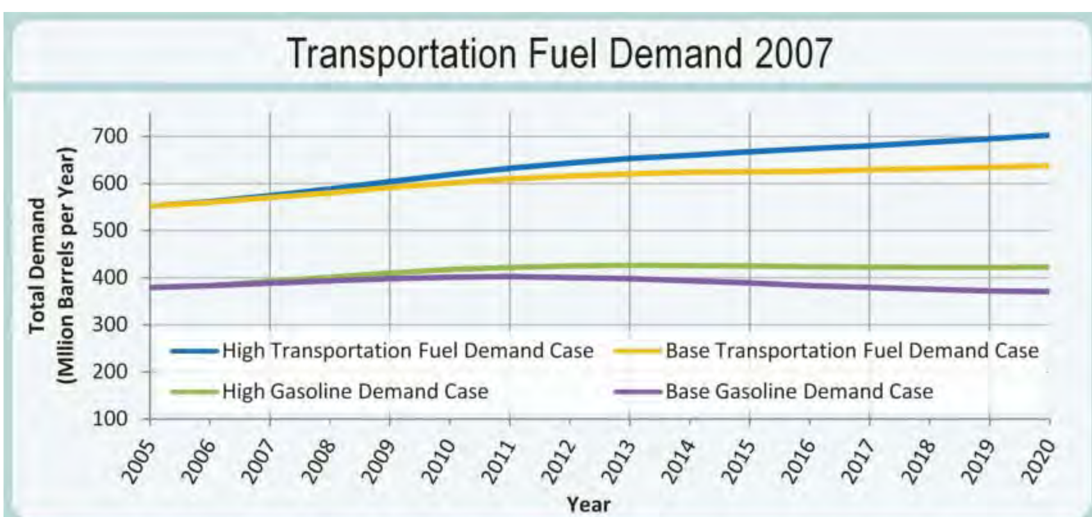
As an example, the Estimated Statewide Transportation Fuel Demand 2007, below, shows projected future fuel consumption in the base case alongside potential high demand scenarios. Aggressive improvements in fuel usage efficiencies and vehicle travel demand management might lead to substantial reductions in future fuel consumption.

A similar forecasting approach can be taken for forecasts of electricity and natural gas consumption, as well as energy use as a component of a local economy, based on existing and estimated future energy costs and local economic output. Current energy expenditures from Step 1 can be compared against the annual gross sales values of all local products and services to determine the relative significance of energy outlays at present. For many communities, energy expenditures equate to 10-15 percent of total local gross economic output. Using projections of energy price increases and local economic growth, a similar assessment can be made for future conditions. In this way, communities can monitor energy among other indicators of economic health and competitiveness.

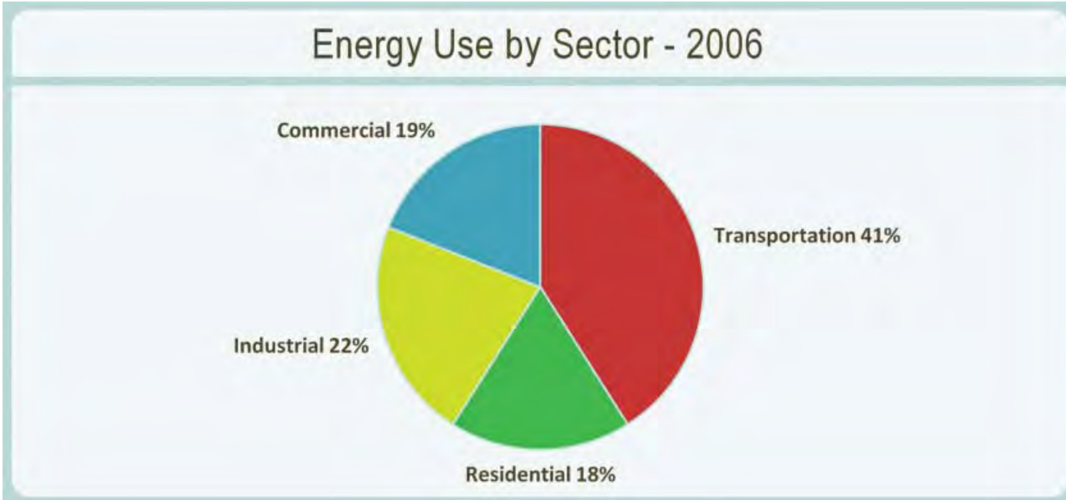
Step 4: Inventory Current Emissions and Evaluate Trends

Consumption of fossil fuel energy produces emissions which can be harmful to human health and lead to climate change impacts. Inventories of greenhouse gas emissions are a critical component of Climate Action Plans and Adaptation Plans (See Section III: Meeting California's Climate Change Challenge), and can be a useful addition to Energy Action Plans as well. GHG emissions inventories can be developed by applying emissions factors to the energy usage profiles developed in Step 2 (for a list of emissions factors, see Appendix A: Emissions Factors). For example, the City of Berkeley's 2005 inventory estimated a citywide total of 576,000 metric tons of GHG emissions. The chart and table below indicate Berkeley's emissions by source, and emissions by sector, respectively.[1]

As in Step 3, communities should analyze current emissions and then apply growth projections to arrive at an estimate of future emissions related to energy consumption. For a list of resources to assist in inventorying GHG emissions, see Resources near the end of this section.



California Energy Commission, 2007.



California Energy Commission, 2007.

City of Berkeley Greenhouse Gas Emissions By Source and Use

Berkeley Greenhouse Gas Emissions (2005)			
Sector	Source	Metric Tons CO2e	Percent
Residential		152,599	26 percent
	Electricity	40,822	
	Natural Gas	111,777	
Commercial/Industrial		157,746	27 percent
	Electricity	61,302	
	Natural Gas	96,444	
Transportation		265,544	47 percent
	Gasoline	169,031	
	Diesel	96,512	
Total Emissions		575,889	100 percent

City of Berkeley, 2009.

Step 5: Set Preliminary Goals

Based on the results of the inventories conducted in steps 4 and 5, set preliminary goals for reducing energy use and greenhouse gases relative to a baseline. The goals should be expressed in terms of a reduction below a baseline level by a target year. For example, the reductions could be expressed as such:

By _____, the City/County will reduce energy use (indicate type of energy) by _ percent below _____levels, and will reduce greenhouse gas emissions by _ percent below _____levels. In setting these preliminary goals, consider how they support regional and state level goals for greenhouse gas reduction.

Step 6: Identify Strategies to Reduce Energy Use

Having identified a community's energy sources, costs, usage, emissions, and potential growth in energy demand and emissions, the next step is to assess specific strategies and best management practices for reducing energy use through energy efficiency and conservation.

Reducing energy usage should be a community priority for several reasons: it reduces energy-related costs, conserves valuable resources, reduces emissions, improves air quality, and lessens the uncertainties of planning for future energy needs and possible supply interruptions. In addition, it supports progress towards state and regional goals for reducing climate change impacts (see Section III – State Greenhouse Gas Requirements). Satisfying growing energy demand with efficiency and conservation is considerably less expensive than investing in new sources of energy, and is more beneficial for the local economy and environment.

Investment in energy efficiency and conservation is the first priority of California's energy policy. It not only reduces direct energy costs, but also has a "multiplier" effect as the investment circulates through a local economy. Studies for the California Energy Commission have found that every additional dollar spent on energy efficiency may result in nearly two dollars of indirect economic activity.[2] This multiplier effect is particularly significant when measured in job creation, since energy efficiency projects tend to be more labor intensive than power generation facilities.[3]

Each end-use sector should be evaluated to identify opportunities for cost-effective efficiency and conservation improvements. The worksheets at the end of this section can assist in this process.

Section V of the Energy-Aware Guide summarizes dozens of specific strategies and best management practices local governments can use to reduce energy use associated with land use, transportation policy, buildings, water use, and other community activities. Communities should select logical groups of strategies that work well together.

Transportation and Land Use Strategies

Section V lists over twenty land use and transportation strategies that municipalities can employ to reduce energy use associated with transportation. These strategies are particularly critical to ensure that regional SB 375 goals are met. SB 375 requires regions in California to reduce greenhouse gases associated with transportation and land use.

There are four major ways local governments can influence the energy use, emissions, and greenhouse gases produced by motor vehicles.

1. Reduce the number of vehicle trips. Reducing vehicle trips has a significant impact on emissions of pollutants, since cold automobile engines release a large amount of pollutants when started.[4] Many of the strategies in the land use and transportation planning sections reduce the number of vehicle trips by making the alternatives to automobile transportation more attractive. Vehicle trips can be eliminated through more compact and diverse development patterns that encourage switching to non-automobile modes of travel (see strategies L.1.1 – L.1.4), Incentives and services such as guaranteed-ride-home programs (see strategy T.2.3), subsidized transit passes (see strategies T.1.1), improved transit service (see strategy T.1.2) ridesharing opportunities (see strategy T.2.4), and comprehensive transportation demand management programs (see strategy T.2.1), can help decrease the number of vehicle trips in a community.

2. Reduce the number of miles driven. Reducing the number of miles driven by vehicles can also limit pollutant emissions, fuel consumption, and greenhouse gases. Typically, vehicles emit about 19 pounds of carbon dioxide for every gallon of gasoline used.[5] Vehicle miles traveled (VMT) can be reduced either by eliminating the vehicle trip (see above) or shortening it. Vehicle trips can be shortened through more compact and diverse development patterns (see strategies L.1.1 – L.1.4), well-connected street patterns (see strategy L.3.1), offering park-and-ride transit access (see strategy T.1.3) and providing access for nonmotorized modes of transportation (see strategies L.4.1-L.4.3).

3. Optimize driving. Fuel economy is typically greatest at moderate speeds, in the range of 30 to 60 mph, and is most optimal at steady speeds with few stops. Speeding, rapid acceleration, and hard braking can lower gas mileage by up to 33 percent and increase greenhouse gas emissions correspondingly.[6] Local governments can design and maintain traffic signals and other control devices to reduce unnecessary stops and delays while still maintaining safety (see strategy T.3.1). Local governments can also educate the public about driving techniques to improve fuel efficiency – see www.eco-drivingusa.com.

4. Drive efficient vehicles. Local governments have limited control over the types of vehicles driven by residents, but they can acquire fuel efficient vehicles for municipal fleets. Municipal fleet acquisition is covered in the Community Energy Strategies Section under C.5.3 Municipal Fleet Fuel Efficiency.

Many of the strategies in the Transportation and Land Use section work best when implemented together, since they frequently have complementary effects. For example, increasing in the cost of parking (see L.2.1. Parking Pricing) could lead to greater transit use. The effect may be stronger if available transit is frequent and reliable (see T.1.2 Increased Transit Service and Improved Travel Time) and low cost (see T.1.1 Transit Fare Measures and Discounts). One recent national study, Moving Cooler, quantified the synergistic benefits associated with implementing packages of transportation and land use strategies.

The Transportation and Land Use Strategies– Energy and Greenhouse Gas Reduction Estimates table at the end of this section may be useful in quantifying the impact of these strategies.

Buildings Strategies

Non-transportation sources represent about 59 percent of all energy used in California, and most of this energy is used in buildings.[7] This energy use can be reduced simply by upgrading light bulbs, appliances, and insulation.

Section V lists seven building energy strategies that municipalities can use to reduce energy consumption. These measures include improving the enforcement of building energy standards (B.1.1), going beyond minimum building energy standards (B.1.2), using solar energy (B.1.3), retrofitting residential and commercial buildings (B.1.4 – B.1.5), installing efficient lighting (B.1.6), and landscaping with shade trees to reduce building temperatures and the need for additional cooling (B.1.7).

The Building Strategies– Energy and Greenhouse Gas Reduction Estimates table at the end of this section may be useful in quantifying the impact of these strategies.

Water Use Strategies

Water use accounts for nearly 20 percent of all electricity consumed in California. About 75 percent of that energy is consumed by end users, while 25 percent is used for supply, treatment before use and wastewater treatment.[8] The energy used for pumping water depends upon the source of the water (e.g., surface or groundwater) and the distance it must travel. Water conservation is the cheapest and most readily available option to extend California's water supplies.

More efficient and sustainable water management solutions, with less economic and environmental costs, are needed. This shift will rely in part on expanded use of efficiency measures including conservation practices, recycling and reuse, and water capture systems; these combine to extend water supplies.

Moving Cooler

Different greenhouse gas reduction strategies implemented at the same time can have complementary effects. Moving Cooler, a study sponsored by 13 federal, nonprofit, and corporate institutions, analyzed the nationwide GHG reduction effects of six bundles of transportation and land use strategies at different levels of implementation:

- **The Near-Term/Early Results Bundle focuses on strategies that could be implemented broadly in the short-term (i.e., before 2015) and that could result in early GHG reduction benefits. Examples of the variety of strategies that can be implemented relatively quickly include: reduced speed limits, increases in urban center parking fees, increased transit level of service, eco-driving programs, and truck stop electrification.**
- **The Long-Term/Maximum Results Bundle focuses on maximizing efforts to reduce GHG emissions without regard to cost, scale, or timeframe of the implementation. This "all-out" bundle includes most of the Moving Cooler strategies: both near-term strategies as well as land use changes, infrastructure investment to expand transportation services, pricing measures, operational improvements, and freight strategies.**
- **The Land Use/Transit/Nonmotorized Transportation Bundle emphasizes the interaction of urban area-focused strategies that increase density and encourage travelers to shift to more energy efficient modes with shorter average trip lengths and increased walking and biking, which would eliminate some vehicle trips.**
- **The System and Driver Efficiency Bundle focuses on strategies that improve multimodal system efficiency by adding capacity, removing bottlenecks, reducing congestion, and improving traffic flow.**
- **The Facility Pricing Bundle focuses on local and regional pricing and incentive strategies (e.g., tolls, congestion pricing, parking fees) that will induce changes in travel behavior by changing the cost of travel. These strategies also could be coupled with service expansion.**
- **The Low Cost Bundle focuses on achieving GHG emission reductions through the deployment of strategies that are more cost-effective.**

The effects of these bundles on greenhouse gas reduction varied, with national reductions ranging from between 4 to 24 percent below baseline by 2050. Layering economy-wide transportation pricing (e.g., increases in the cost of fuel) on top of the bundles results in substantial additional reductions of as much as 17 percent under an aggressive scenario. Within the bundles, the strategies that contribute the most to GHG reductions are local and regional pricing and regulatory strategies that increase the costs of single occupancy vehicle travel, regulatory strategies that reduce and enforce speed limits, educational strategies to encourage eco-driving behavior that achieves better fuel efficiency, land use and smart growth strategies that reduce travel distances, and multimodal strategies that expand travel options. The analysis also shows that some combinations of strategies could create synergies that enhance the potential reductions of individual measures. In particular, land use changes combined with expanded transit services achieve stronger GHG reductions than when only one option is implemented.

Moving Cooler is available from the Urban Land Institute at http://www.uli.org.

Section V lists five water use strategies that cities and counties can use to reduce water-related energy consumption. Consider strategies that reduce stormwater runoff and associated impacts (W.1.1); improve water-efficient landscaping practices (W.2.1); conserve water by pricing it according to the true cost of developing, storing, treating, and providing service (W.2.2); promote the re-use and recycling of water supplies (W.3.1); and efficiently treat community wastewater (W.4.1).

The Water Strategies– Energy and Greenhouse Gas Reduction Estimates table at the end of this section may be useful in quantifying the impact of these strategies.

Other Community Strategies

Cities and counties can use a number of additional community strategies to manage their energy use and energy supplies beyond the transportation, land use, building and water sectors. Examples include:

» Establishing or taking part in an existing community-wide energy efficiency program (C.1.1)

» Establishing an energy financing district program to fund energy efficiency projects and clean generation (C.1.2)

» Using vegetation, cool roofing materials, and cool pavement materials to reduce the urban heat island effect and associated electricity usage (C.1.3)

» Promoting the consumption of locally-grown food (C.3.1)

» Reducing solid waste (C.4.1)

» Implementing energy efficient municipal procurement practices, such as purchasing re-used, recycled, or sustainably sourced products, buying electricity from renewable resources, and procuring fuel efficient vehicles for municipal fleets (C.5.1 and C.5.3); and

» Designing an efficiency program for municipal facilities (C.5.2).

There are many resources beyond the Energy Aware Planning Guide that local governments can use to identify and evaluate energy and greenhouse gas reduction strategies. The California Air Pollution Control Officers Association recently published Model Policies for Greenhouse Gases in General Plans. The document contains many model policies for reducing greenhouse gas emissions, including those relating to land use, transportation, energy efficiency, alternative energy, municipal operations, waste reduction, conservation, and education, and provides a worksheet for evaluating the expected impact of the policies. The worksheet contains spaces where the user can fill in the following for each model policy:

- **Implementation examples;**
- **Appropriate general plan element where the referenced model policy could be incorporated;**
- **Relative effectiveness at reducing GHGs (e.g., 1 through 5 or low, medium, high);**
- **Relative difficulty to implement (e.g., low to high difficulty);**
- **Relative time for reductions to occur (e.g., short-, medium-, long-term); and**
- **Relative cost (e.g., low to high cost).**

The Community Energy Strategies– Energy and Greenhouse Gas Reduction Estimates table at the end of this section may be useful in quantifying the impact of these strategies.

Step 7: Identify Renewable Resource Strategies

After ensuring energy is used as efficiently as possible, a community should next consider its ability to develop local renewable resources as a means of reducing reliance on nonrenewable energy supplies, increasing supply diversity and strengthening the local economy.

Although much of the transition to renewable energy sources will happen statewide in response to the Renewable Portfolio Standard (see sidebar), local communities have a role to play. Several California communities can point to substantial renewable power sectors in their local economies, generating kilowatt hours as well as hundreds of jobs, millions of dollars in annually purchased goods and services, and significant tax revenues for local agencies. Examples include geothermal projects in Imperial, Lake, and Sonoma Counties[9] and wind projects in Alameda County and solar projects in diverse locations. In some cases, California communities are even generating their own renewable-based energy, either for internal consumption or public sale. Siskiyou County, for example, owns a hydroelectric facility and sells its output to the local electric utility.

The worksheets at the end of this section outline the basic parameters of a renewable resource inventory and sources of assistance for its completion. More information on renewable energy strategies can be found in Section V under "Community Energy Strategies." Examples include:

» Using solar resources to reduce building energy demand and generate power (using solar energy, B.1.3)

» Using distributed energy resources to provide an alternative to or an enhancement of the traditional electric power system (C.2.2)

» Implementing energy efficient municipal procurement practices, such as buying electricity from renewable resources (C.5.1 and C.5.3)

Wind turbines in the Altamont Pass.
Source: Wikimedia Creative Commons/David J Laporte.

The Renewable Portfolio Standard

Under the state Renewables Portfolio Standard (RPS), investor-owned utilities must increase sales of electricity supplied by renewable energy sources such as wind, solar, geothermal, hydroelectricity, and biomass energy (e.g. energy from landfills, wastewater and dairy methane), by one percent per year until total sales reach 20 percent. This policy has been driving renewable energy generation statewide. The RPS is based on electricity sales, so electricity generated by consumers (including municipalities) through their own equipment (such as rooftop solar photovoltaics) is not counted towards the RPS.

Step 8: Analyze Findings

The next step is to summarize findings from all previous steps to assist in the identification of the highest priority action items, allowing local officials to refine goals and make informed policy choices in the next phase of local energy planning. The following issues should be addressed in the summary:

Energy Supplies

» What proportion of supplies are produced locally versus imported? What proportion of supplies are produced from renewable or non-renewable sources?

» How diverse is the mix of supplies, and is there over-reliance on any particular source? How vulnerable is the community to supply interruptions, and is there a contingency plan for interruptions?

» What are the significant environmental effects, including greenhouse gas impacts, associated with energy production, distribution, and use?

» How much of the local economy is dedicated to importing energy supplies and how much local employment is sustained by supply activities? What are the overall costs of energy supplies for the community, and for typical households and businesses?

Energy End-Uses

» What are the largest consumers of energy in the community, and in what sector is use growing the fastest?

» How do local consumption patterns compare to similar communities?

» Are there significant environmental effects associated with particular energy end-uses?

» What mechanisms are available for ongoing measurement of local energy use and future changes?

Energy Reduction Strategies

» Which energy conservation or efficiency strategies are the most promising? Consider likely magnitude of impact; ease of implementation; potential for economic benefit; and funding availability. Also consider how packages of strategies could work together synergistically if implemented simultaneously.

» Which organizations have the authority to implement the selected strategies?

» What regional partnerships can be formed or joined to leverage resources?

Renewable Resource Strategies

» Which local undeveloped renewable resources have the greatest potential for producing beneficial energy, and which can be feasibly developed in order to displace imported supplies and/or create supply exports?

» What are the likely environmental effects of local renewable energy development? What would be the local economic effects?

» Will local renewable energy development also require new or expanded energy transmission facilities, and if so, what would be the impacts?

» Which organizations are key players in the sponsorship and regulation of renewable resource projects, and what types of technical and financial assistance are available for implementing renewable energy projects?

Step 9: Finalize Goals, Action Steps, and Monitoring Measures

The information in step 8 should allow the Energy Action Plan team to approach goal-setting and policy-making with a clear understanding of current energy circumstances and the problems and opportunities that must be addressed to ensure a locally reliable, affordable, and environmentally acceptable energy future. The final steps are to:

» Finalize a list of high-priority action steps. Identify strategies from the lists developed in Steps 6 and 7 and condense them into high priority action steps. Identify the time frame of implementation (e.g. early implementation; medium-term; and long term) and the agencies and individuals responsible for implementation. Identify available tools, funding sources, and incentives to support implementation.

» Refine goals. Using the list of high priority actions, refine the initial goals developed in Step 5 so that they are realistic given the magnitude of benefit expected if the plan action steps are implemented. Consider how the refined goals support regional and state-level energy and climate change goals.

» Identify performance measures. Performance measures should be included in the plan to ensure progress towards goals is tracked over time.

» Integrate goals and action with plans, programs, and processes. Goals and action steps in the plan should be consistent with related plans and programs, such as the city general plan, the regional transportation plan, and the sustainable communities strategy. The approval of future community capital projects should be determined in part by the degree to which they are consistent with the Energy Action Plan. Development review checklists can be used to ensure the new projects are consistent with the goals and action steps in the plan.

Step 10: Write and Adopt the Plan

The last step is to finalize the plan and formally adopt it through public process.

Resources

Published in 2008, the Local Government Operations Protocol provides guidance on the quantification and reporting of municipal GHG emissions inventories, including municipal facilities, vehicle fleets, energy generation, solid waste, and wastewater treatment. Available on-line at http://www.arb.ca.gov/cc/protocols/localgov/pubs/final_lgo_protocol_2008-09-25.pdf.

The U.S. Environmental Protection Agency's Emission Inventory Improvement Program has developed a set of preferred methods for collecting data and calculating emissions as well as useful procedures for quality control. Available on-line at http://www.epa.gov/ttn/chief/eiip.

ICLEI – Local Governments for Sustainability provides a number of services, including community-level emissions inventory methodologies for over 700 local governments worldwide. The city of Berkeley teamed with ICLEI to develop an emissions inventory for its June 2009 Climate Action Plan. More information is available at http://www.iclei.org. ICLEI is also developing the Climate and Air Pollution Planning Assistant (CAPPA), a decision-support tool that calculates the cumulative emissions benefits from a wide range of strategies based upon user inputs. Finally ICLEI offers a Climate Action Plan Template, available from http://coolcalifornia.org.

The California Air Pollution Control Officers Association (CAPCOA) has published Model Policies for Greenhouse Gases in General Plans, which provides background information, examples, references, links, and a systematic worksheet to assist local governments in considering GHG issues in General Plan updates and in the development of Climate Action Plans. Available on-line at http://capcoa.org/modelpolicies/document.

The Center for Clean Air Policy (CCAP) offers a number of valuable resources for local governments interested in reducing energy consumption, increasing efficient energy use, and investigating renewable energy possibilities. Available on-line at http://www.ccap.org/index.php?component=resources&by=issue.

The Governor's Office of Planning and Research offers a list of General Plan guidelines at http://www.opr.ca.gov/planning/publications/General_Plan_Guidelines_2003.pdf.

ICLEI - Local Governments for Sustainability developed a Climate Action Plan Template with funding through Alameda County's StopWaste.org. Local governments can adopt the Climate Action Plan as a stand alone element to the General Plan or the individual measures of the Climate Action Plan can be integrated throughout the General Plan. The recommended table of contents includes:

1. **Front matter: a letter of support from an elected official and acknowledgements**
2. **Introduction: background information on climate change science**
3. **Inventory: an inventory of current sources of greenhouse gas emissions (for both municipal operations and community-wide),**
4. **Forecast: a forecast of future emissions of greenhouse gases**
5. **Targets: a discussion of greenhouse gas targets**
6. **Strategies: presentation of key strategies to achieve greenhouse gas reduction targets, including those targeting the building, transportation, water, and solid waste sectors. Strategies implemented external to the community could also be included.**
7. **Conclusion and Guide for Future Steps.**

The template may be accessed from http://coolcalifornia.org.

Endnotes

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ENERGY INVENTORY WORKSHEETS

Energy Sources Worksheet

Imported Supplies	Inventory Items	Data Sources
Electricity	Generating plant locations and fuels or renewable resources	Local electric utilities; California Energy Commission
	Transmission and distribution system status	
	Annual quantity distributed	
	Current customer rates	
Natural gas	Production area locations	Local natural gas distributors and utilities; California Energy Commission; California Public Utilities Commission
	Transmission and distribution system status	
	Annual quantity distributed	
	Current customer rates	
Fuel oil & propane	Refinery locations	Local fuel oil and propane distributors
	Distribution methods	
	Annual quantity distributed	
	Current customer prices	
Transportation fuels	Production/refinery locations	Local transportation fuel distributors; California Energy Commission
	Distribution methods	
	Annual quantities distributed (gasoline, diesel, alternative fuels)	
	Current customer prices	
Local Supplies		
Electricity	Generating plant locations and fuels or renewable resources power producers	Local electric utilities; independent power producers
	Transmission and distribution system status	
	Current customer rates	
	Annual quantity distributed	
Renewable direct-uses (solar, geothermal, wind, biomass, etc).	Number, type, and size of installations	Local equipment vendors and installers; local planning department; local electric utilities; California Energy Commission
	Total estimated annual output	

Energy Uses Worksheet

Current Uses	Inventory Items	Data Sources
Residential	Dwelling numbers and characteristics	General Plan Housing Element; local building officials; federal surveys (see reference list)
	Prevalent fuels and equipment types (heat pump, etc)	Local energy utilities (electric and natural gas consumption available by zip code); federal surveys; California Energy Commission
	Annual energy usage (e.g. electricity and natural gas consumption, typical dwellings and sector total)	
Commercial	Building numbers and characteristics	Local building officials; federal surveys
	Prevalent fuels and equipment types	Local energy utilities; federal surveys; California Energy Commission
	Annual energy usage (typical buildings and sector total)	
Institutional	Building numbers and characteristics	Local agencies' facility managers; California Energy Commission
	Prevalent fuels and equipment types	
	Annual energy usage (typical buildings and sector total)	
Industrial	Company types and numbers	Local economic development agency
	Prevalent fuels and equipment types	Local energy utilities; industry representatives
	Annual energy usage (typical companies and sector total)	
Agriculture	Farm/ranch numbers and characteristics	County annual agricultural report; Federal Census of Agriculture
	Prevalent fuels and equipment types	Local energy utilities; agricultural trade groups; California Energy Commission
	Annual energy use (typical farms/ ranches and sector total)	
Transportation	Vehicle numbers and types	State Department of Motor Vehicles
	Annual vehicle miles traveled and fuel efficiencies	Metropolitan Planning Organizations, Caltrans Motor Vehicle Stock Travel, and Fuel Forecast
	Total annual vehicle fuel consumption	Caltrans California Motor Vehicle Stock Travel, and Fuel Forecast
	Public transit operating characteristics	Local transit agencies National Transit Database
	Total annual public transit fuel consumption	
Public Infrastructure	Water supply pumping energy use	Local water agencies
	Wastewater pumping and treatment energy use	Local wastewater agencies
	Street lighting energy use	Local public works agencies; Caltrans
Future Uses		
Electricity and Nontransportation fuels	Population projections for 5, 10, and 20 year horizons	California Department of Finance; local General Plan
	Price Forecasts	Local energy utilities; California Energy Commission
Transportation fuels	Population projections and per capita driving coefficients	California Department of Finance; local General Plan; Caltrans
	Price forecasts	California Energy Commission

Worksheet for Identifying Energy Efficiency Opportunities

Buildings	Efficiency Opportunities	Data and Assistance Sources
Residential, Commerciall, Institutional	Percent of buildings pre-dating Title 24 statewide efficiency standards	General Plan Housing Element; Local building officials
	Major appliance efficiency (furnaces, etc)	Local energy utilities (appliance saturation surveys)
	Percent of older buildings audited for efficiency improvements	Local energy utilities and building officials
	Number of older buildings retrofitted to date with high efficiency lights and/or space conditioning systems	
	Use of home energy rating system during sales of older residences	Local building officials
	Enforcement level of state energy efficiency standards for new construction (Title 24)	
	Percent of new construction voluntarily exceeding Title 24	
	Percent of existing housing stock and new permits for mobile homes not subject to Title 24	General Plan Housing Element; local building officials
	Participation levels in utility efficiency incentive and energy education programs	Local energy utilities; California Energy Commission Hotline; American Council for an Energy-Efficient Economy
	Availability of technical training in efficiency techniques and technologies	Local schools and vocational training sources; California Energy Commission; California Building Officials (CALBO)
Industry	Thermal and/or mechanical processes suitable for updating	Local industrial trade groups
	Waste products not currently being recycled	
	Waste heat suitable for co-generating electricity and process heat	
	Participation levels in utility efficiency incentive programs	Local energy utilities
Agriculture	Fuel requirements for mechanized farming	Federal Census of Agriculture
	Number of irrigation pumps retrofitted with high efficiency motors	Local energy utilities
	Local participation levels in Energy Commission and utility programs	California Energy Commission and local energy utilities
Land-Use and Transportation	Vehicle miles traveled annually	Metropolitan Planning Organizations - travel demand model California Motor Vehicle Stock Travel, and Fuel Forecast (MVSTAFF) – Provides vehicle miles traveled and fuel consumed by county
	Average local commute distances and times	U.S. Census Local transportation agencies
	Amount of productive time lost in local traffic congestion	Texas Transportation Institute (for metropolitan regions)
	Availability and use of vehicle occupancy measures such as ridesharing and high occupancy vehicle lanes	U.S. Census provides the percent of residents who carpool to work
Land-Use and Transportation (continued)	Availability and use of vehicular alternatives (transit, walking, etc).	U.S. Census - percent of residents commuting by mode of transport .
	Availability of bicycle and pedestrian facilities	Local transportation agencies, bicycle and pedestrian plans, satellite imagery (www.google.com)
	Degree of land use density and diversity; amount of new development incorporating pedestrian/bicycle/transit friendly design features	Local planning agencies
	Presence of priced/managed parking	Local transportation agencies; parking authorities
	Presence of land-use plans encouraging high-density, mixed uses	Local planning agencies

Public Infrastructure	Participation levels in water conservation programs	California Department of Water Resources; Water Education Foundation; Committee on Water Policy Consensus; local water agencies
	Number of water supply systems audited and retrofitted with high efficiency pumps and controls	Local water agencies; energy utilities
	Number of wastewater treatment systems audited and retrofitted with high efficiency pumps, treatment processes and controls	Local wastewater agencies; energy utilities; California Energy Commission
	Level of training of plant operators	Water Quality Control Institute (of State Water Resources Control Board)
	Number of streetlights retrofitted with high efficiency lamps	Local transportation agencies; Caltrans; energy utilities
Solar	Local levels of solar radiation	Local solar designers; equipment vendors and installers; California Energy Commission
	Direct thermal application technologies and environmental issues	
	Electric generation technologies and environmental issues	
Biomass	Location, quantity, and quality of biomass supplies: wood, agricultural wastes and municipal solid wastes	Land and waste management agencies; trade groups; U.S. Forest Service
	Direct thermal application technologies and environmental issues	Local designers; equipment vendors and installers; air quality management districts; California Energy Commission
	Electric generation technologies and environmental issues	Energy utilities; independent power producers; air quality management districts; California Energy Commission
Geothermal	Location, quantity, and quality of resource types: low-temperature groundwater, moderate-temperature hot water, and high-temperature steam	CA. Division of Oil and Gas; U.S. Geological Survey; USDOE; energy utilities; independent power producers; equipment vendors and installers; California Energy Commission
	Direct thermal application technologies and environmental issues	
	Electric generation technologies and environmental issues	
Wind	Location, quantity, and quality of resource sites according to average wind speeds	Energy utilities; independent power producers; equipment vendors and installers; California Energy Commission
	Electric generation technologies and environmental issues	
Hydro	Location, head, flow, and potential generating capacity of river reaches	California Department of Water Resources; Federal Energy Regulatory Commission; energy utilities; independent power producers; equipment vendors and installers; California Energy Commission
	Location and capacity of existing hydraulic facilities with generation retrofit potential	
	Electric generation technologies and environmental issues	

Community Energy Data Summary

Conventional Fuels Use Data				
Fuels/Resources		Consumption/Year		
Energy Type	Fuel/Resource	Quantity	Unit	Common Qty w/o eff. (MMBtu)
Transportation	Gasoline Diesel Alt. Fuel		Gal Gal Gal	
Electric & Thermal	Fuel Oil Propane Electricity Natural Gas		Gal Gal MWh THerms	

Fuels Cost Data							
Fuels/Resources		Local Fuel Costs					
		Fuel Cost ($)		Cost Unit			
Energy Type	Fuel/ Resource Type	Power	Direct Application	Power	Direct Application	Conversion Efficiency(%)	Common Cost w/ eff. ($/MMBtu)
Transportation	Gasoline Diesel Alt. Fuel				Gal Gal Gal		
Electric and Thermal	Fuel oil Propane Electricity Natural gas			 K Wh 	Gal Gal Therms		

Renewable Energy Resources Data

Fuels/Resources		Local Renewables								Exported Renewables/Year				
		Undeveloped Inventory				On-line								
		Undeveloped		Power Potential (MW)	Direct App. Potential (MMBtu/Yr)	Power		Direct Applications		Quantity Exported/Year		# Jobs Created	Revenues	
Energy Type	Fuel Resource Type	Quantity	Units			MW	Jobs	MMBtu/hr	Jobs	Power (MWh)	Fuel (Tons)		Public ($)	Private ($)
Electrical and Thermal	Biomass Geothermal Wind Hydro Solar		Tons/yr MW MW MW MW											

End Use Sectors Data

End-Use	No. Vehicles	Total Miles/Yr. (million)	Average MPG	Total Gal. (Million)	Average Cost/Gal ($0)	Total Cost ($/yr)
Private Sector Auto						
Private Sector Truck						
Ag. Equipment						
Local Govt. Vehicles						
Total						

End-Use	No. Bldgs Or Facilities	Total Sq Ft	Usage/Sq Ft (MM Btu/ Sq Ft Yr)	Usage/Facility (MMBtu/ Fac/Yr)	Total Usage (MMBtu/Yr)	Ave Cost Per Unit ($/ MMBtu)	Total Cost ($/Yr)
Residential							
Commercial							
Agriculture							
Industrial Local Govt.							
Total							

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ENERGY AND GREENHOUSE GAS REDUCTION ESTIMATES

The tables in this section provide information that may be helpful in the calculation of the energy and greenhouse gas reduction benefits of the strategies in the Transportation and Land Use section of the guidebook. In some cases, calculators may be available to assist (see Calculators below).

How much energy use is associated with transportation?

The California Energy Commission has estimated that the transportation sector is the largest consumer of energy in California, accounting for 41 percent of all energy consumed in the state.[1] Passenger vehicles account for 74 percent of emissions from the transportation sector.[2]

Energy consumed by the transportation sector comes almost exclusively from fossil fuels, principally gasoline and diesel fuels. Carbon dioxide, a major greenhouse gas, is produced in proportion to consumption of these fuels. Typically, vehicles emit about 19 pounds of carbon dioxide for every gallon of gasoline used (see Appendix A). Vehicles also produce small quantities of other pollutants that have climate impacts, such as methane, nitrous oxide, and black carbon.

How is transportation energy use related to land use?

Transportation and land use are inextricably linked—the location, type and density of new development has critical consequences for vehicle congestion, vehicle miles traveled (VMT), and associated energy use and GHG emissions.

Compact land use patterns zoned for a variety of closely spaced destinations encourage walking, bicycling, and use of public transit, therefore reducing VMT and fuel use. Central business districts with subsidized parking and freeway access will incentivize single-occupant vehicle travel and create more demand for travel on roadway networks.

Changes to the transportation network have a direct impact on energy consumption as well. Building a roadway for a higher traffic volume or adding freeway exits in absence of demand (such as would be demonstrated by an economic activity simulation) creates the conditions for sprawl and increase VMT. Locating attractions such as shopping malls or sports and entertainment arenas at the urban periphery has the same effect.

Dispersed, decentralized land use patterns are inconvenient for walking, bicycling, and using public transit, with the result that using personal vehicles is convenient. "Smart" urban and transportation design contribute to reversing this trend. The coexistence of residences, environmentally benign workplaces, and neighborhood retail services in a planned pattern of closely-spaced destinations will encourage walking and bicycling. Adding bus-only ramps and diamond lanes on impacted existing freeways facilitates the use of regional public transit and ridesharing, thereby reducing VMT and its associated energy consumption.

How do the transportation and land use strategies in the Energy Aware Planning Guide reduce energy use?

There are two major ways the Energy Aware Guide strategies reduce energy use from the transportation sector: by improving vehicle fuel efficiency, and by reducing the number of miles traveled.

How can I estimate energy savings and greenhouse gas (GHG) reductions from the transportation strategies?

For strategies that reduce the number of miles driven, the major analytical steps are:

1. Estimate the amount of driving (vehicle miles traveled) in the target location that is occurring or would occur if no action were taken;

2. Estimate the amount of driving that would occur after implementation of the strategy;

3. Estimate the VMT avoided by implementing the strategy (subtract #2 from #1).

4. Convert the energy savings into GHG reductions using the conversion factors provided in Appendix A.

For strategies that improve fuel economy, the major analytical steps are:

1. Estimate the number of miles driven in the target area or by the target group of individuals.

2. Convert the result to a measure of fuel consumed using the conversion factors provided in Appendix A and assuming current fuel economy.

3. Repeat step 2 but assume an improved fuel economy (fuel economy improvements can result from changes in the vehicle size or engine, reduced congestion, reductions in aggressive driving habits, and in improved vehicle maintenance).

4. Subtract the result of step 3 from step 2 to determine the amount of fuel saved as a result of the measure. Convert the result into greenhouse gases avoided using the conversion factors in Appendix A.

Table 1. Land Use Energy Aware Strategies – Relevant Facts

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
L.1.1 – L.1.4 Smart Growth Development Opportunities, Land Use Diversity , Transit Oriented Development , and Design		
Apply smart growth principles at development sites	Reduce auto vehicle miles traveled (VMT)	Applying smart growth principles (density, diversity, design, distance to transit, etc.) at a specific site can reduce vehicle miles traveled by approximately 20-40 percent[3] compared to conventional development. The degree of benefit depends on the details of the design and the development context.
L.1.5 Freight Movement Planning		
Freight VMT reduction strategies	Reduce vehicle miles traveled (VMT) from freight vehicles	Ground and air goods movement consumed roughly 18 percent of California's Nonmilitary transportation gasoline and diesel fuels in 2007 by volume.[4] Heavy trucks consumed about 92 percent of California's total roadway diesel fuel.[5] Local governments can reduce freight VMT and improve fuel efficiency through more direct routing of freight trips, encouraging off-peak deliveries, and other strategies.
L.2.1-L.2.2 Parking Pricing and Parking Supply Management		
Implement progressive parking pricing and management policies	Reduce vehicle miles traveled Improve vehicle fuel economy if congestion is reduced	Research indicates that if the price of parking is doubled, solo driving can be expected to decrease by approximately 10 - 30 percent.[6] Motorists are expected to spend an average of 3.5 to 13.9 minutes searching for on-street parking, and surveys have indicated that 8 - 74 percent of urban traffic congestion is the result of vehicles searching for curb parking.[7] A 1999 study found that roughly 35 percent of solo driving commuters would switch modes if free parking was raised to $20 per month.[8]
L.3.1 Complete Streets & Street Design		
Improve the directness of vehicle, bicycle, and pedestrian routes	Reduce vehicle miles traveled	A grid street pattern, as opposed to the conventional suburban network of cul-de-sacs and collector streets funneling all traffic to arterials, is expected to reduce VMT within a development by approximately 50-60 percent due to more direct routing.[9] Direct connections can also encourage more walking and bicycling.
Light, narrow street design	Reduce ambient air temperatures and energy use associated with air conditioning.	Narrower, lighter colored, and shaded streets are anticipated to reduce air conditioning demand by 10-30 percent by reducing ambient temperatures.[10]
L.3.2 Street Trees		
Plant street trees	Reduce ambient temperatures and energy use associated with air conditioning.	One Davis study found that evening ambient temperatures in neighborhoods with well shaded streets are up to 10 ºF (5.5ºC) cooler than areas with less shading.[11] A 1ºC change in average summer temperature for a large region is anticipated to affect total electricity use by 1-2 percent due to the need for space cooling. Even when increased winter heating needs are considered, a 1ºC change could reduce overall electricity use by about 0.50 percent to over 1.10 percent.[12]
L.4.1-L.4.2 Bikeways, Bicycle Parking and Facilities, and Pedestrian Facilities and Traffic Calming		
Pedestrian and bicycle facilities	Reduce vehicle miles traveled	Implementation of area wide pedestrian and bicycle improvements is expected to reduce VMT approximately 1-10 percent. Effectiveness increases in densely populated urban neighborhoods.[13]

Table 2. Transportation Energy Aware Strategies – Relevant Facts

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
T.1.1 Transit Fare Measures and Discounts		
Fare discounts	Reduce vehicle miles traveled	One study found that a 10 percent drop in bus fare can be expected to increase ridership by an average of 3.6 percent in cities of over one million residents, and by 4.3 percent in cities of less than one million residents;[14] a 10 percent drop in light and heavy rail fares results in 3 percent and 1.7 percent increases in ridership, respectively.[15] Only a fraction of new riders are thought to shift away from driving.
T.1.2 Increased Transit Service and Improved Travel Time		
Increased service	Reduce vehicle miles traveled from passenger vehicles (note that vehicle miles traveled by transit vehicles could increase under this strategy and should be taken into account)	According to several studies of traveler response to service improvements, a one percent increase in bus service frequency can generally be expected to result in a half percent improvement in ridership, while a 10 percent increase in bus service will generally attract a 5 percent increase in ridership. Only a fraction of this increase includes passengers shifting from driving. Adding additional service hours (such as late evenings and early mornings) may be just as important as increasing frequency in peak hours.[16] Off-peak travel is reported as generally more responsive to service increases than peak travel.[17]
T.1.3 Park-and-Ride Lots		
Park-and-ride lots at transit stations	Reduce vehicle miles traveled associated with commute trips	Generally, about 40-60 percent of rail park-and-ride facility customers previously drove alone to their end destination, while the remainder previously took the bus, carpooled, or took an alternate mode. VMT reduction varies, with lots on the urban fringe typically resulting in higher levels of VMT reduction.[18] Rail transit park-and-ride lots tend to be more effective than bus park-and-ride lots.
T.2.1-T.2.4 Transportation Demand Management Programs, Transportation Management Associations, Guaranteed Ride Home Programs, and Ridesharing		
Comprehensive TDM programs	Reduce vehicle miles traveled associated with commute trips	Travel reductions of 10-30 percent at target worksites are typical for comprehensive TDM programs (e.g. including multiple strategies such as planning, marketing, ridematching) implemented by local or regional governments.[19] Achieving reductions at the high end of the scale generally requires offering of financial incentives (e.g. parking cash out programs, vanpool subsidies) in addition to marketing and services.[20]
T.2.5 Carsharing		
Carsharing programs	Reduce vehicle miles traveled	The extent of benefit depends on how much members would have driven if they did not have access to a carsharing service — one analysis suggests direct VMT reductions of 0.1 percent to 0.2 percent in typical regions, with potentially greater effects in urban neighborhoods.[21]
T.2.6 Telework		
Offer employees the ability to work from home	Reduce vehicle miles traveled associated with commute trips Improve fuel economy if congestion is reduced	Telecommuting eliminates some commute trips and can relieve urban congestion, but may not reduce net travel in all cases if workers make additional trips at home or live farther from their worksite because of the telework option. One study estimated that 1-2 percent of vehicle travel could be reduced by telework. Long-term impacts may be even smaller if it encourages more urban dispersion.[22]
T.2.7 Alternative Work Schedules		

Table 2. Transportation Energy Aware Strategies – Relevant Facts (continued)

Compressed work weeks	Reduce vehicle miles traveled associated with commute trips Improve fuel economy if congestion is reduced.	Studies have found that compressed work weeks can reduce vehicle commutes by 7-10 percent.[23] Some additional travel may occur on days that workers stay at home - one study estimates an additional six miles of non-work-related travel for each day spent at home rather than working.[24]
Staggered work hours	Improve vehicle fuel economy	Flex-time and staggered work hours can reduce congestion by shifting trips out of the peak period, allowing vehicles to travel at steady speeds. One study indicated that fuel consumption increases 30 percent when average speeds drop from 30 to 20 mph. A drop from 30 to 10 mph can result in a 100 percent increase in fuel use.[25] Employees with flex-time have been found to save an average of seven minutes per day in time spent commuting.[26]
T.3.1 Traffic Signal Timing		
Retiming traffic signals	Improve vehicle fuel economy	Cities participating in California's Fuel Efficient Traffic Signal Management (FETSIM) Program reduced fuel consumption by 7.8 percent.[27] Traffic signal timing can reduce vehicle idling and delay by 4-13 percent along a busy arterial corridor.[28]

Calculators

The Center for Clean Air Policy (CCAP) maintains a Transportation Emissions Guidebook, which includes an emissions calculator that may be accessed online. The user specifies policies and network information and the calculator returns estimated emissions reduction. http://www.ccap.org/safe/guidebook/guide_complete.html.

ICLEI's Climate and Air Pollution Planning Assistant (CAPPA), in Microsoft Excel format, calculates the greenhouse gas and air pollution reduction benefits of many local government strategies. Those most relevant to transportation and land use include: bikes & transit; transit education; bike paths; bike police; bus service increases; bus rapid transit; parking cashout; walking; increased bus use; increased rail use; carshare; carpool; telecommute; light rail; improved safety on routes to schools; free bikes; high school bus passes; and transit oriented development. http://www.icleiusa.org/action-center/tools/decision-support-tool.

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ENERGY AND GREENHOUSE GAS REDUCTION ESTIMATES

The tables in this section provide information that may be helpful in the calculation of the energy and greenhouse gas (GHG) reduction benefits of the strategies in the Building section of the guidebook. Many of these benefits can be modeled precisely for specific installations using the California Energy Commission's Database for Energy Efficient Resources (DEER) calculator. Other calculators are also available (see Calculators below).

How much energy use is associated with buildings?

Nontransportation sources represent about 59 percent of all energy used in California. Most of this energy is used in buildings. The largest sector is industrial (22 percent), followed by commercial (19 percent) and residential (18 percent).[1]

» The industrial sector uses 16 percent of the electricity and 23 percent of the natural gas consumed in California.[2]

» The residential sector uses 32 percent of electricity and 22 percent of natural gas consumed in California. Space and water heating account for 88 percent of the natural gas consumption.[3]

» The commercial sector uses 37 percent of the electricity and 10 percent of the natural gas consumed in California.[4] The primary electric end uses are interior lighting (29 percent), cooling (15 percent), refrigeration (13 percent), and ventilation (12 percent). The primary natural gas end uses are for space heating (36 percent), water heating (32 percent), and cooking (23 percent).[5]

Table 1 presents the typical energy usage per square foot for commercial and office buildings. Detailed tables by commercial building type and end use are available from the source report.

Table 1. Energy Intensity by Building Type in California [6,7]

Nonresidential Buildings	Electricity / square foot (kWh/ft2 – yr)	Natural gas / square foot (BTUs / ft2 – yr)
All commercial buildings	13.63	26
All offices	16.08	17.90
All warehouses	6.74	3.40
Residential Buildings	Electricity / capita (kWh/year – 2005)	Natural gas / capita (BTUs / year – 2005)
Residential per capita	2,379	13.7

Note: there can be considerable variation in energy intensity by building sub-types. Restaurants, food stores, and large office buildings tend to be particularly energy-intensive. Detailed energy intensity by type of commercial building and end use are available from the source report.

How do the building strategies in the Energy Aware Planning Guide reduce energy use?

Strategies in the building section of the guide reduce energy from buildings by either:

» Improving the energy efficiency of building fixtures and appliances (e.g. more efficient lighting, appliances).

» Reducing building electricity and natural gas needs by reducing energy demands (e.g. by improving building insulation or shading the building with trees).

» Reducing demand for building energy supplies (electricity and natural gas) through behavioral and pricing changes.

Additionally, some strategies are provided which provide alternative sources of power, such as solar or wind power. These strategies do not reduce energy use but reduce or eliminate greenhouse gases associated with energy production.

How can I estimate energy savings and greenhouse gas reductions from the building strategies?

The major analytical steps are:

1. Estimate the amount of energy currently consumed by the building.

2. Estimate the amount of energy that would be consumed if the strategy were implemented.

3. Estimate the energy savings associated with the energy-efficiency measure (subtract #2 from #1).

4. Convert the energy savings into greenhouse gas reductions using the conversion factors provided in Appendix A (e.g. typical amount of greenhouse gases produced per unit of energy).

Table 1. Energy Aware Strategies - Relevant Facts

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
B.1.1 Improve Enforcement of Building Energy Standards		
Improve enforcement of standards	Reduces amount of energy needed by buildings	Benefits could be calculated by determining the number of buildings that will meet standards as a result of better enforcement and the expected energy reduction that would result by building type.
B.1.2 Going Beyond State Building Energy Standards		
Go beyond building energy standards	Reduces amount of energy needed by buildings	Benefits could be calculated by determining the number of buildings that would go beyond standards and the expected energy reduction that would result by building type.
B.1.3 Encouraging Solar Resources		
Passive solar features	Reduces the amount of energy needed to heat and cool buildings	Orienting well-insulated buildings to maximize southern window exposure and minimizing windows on the east and west walls can reduce heating and cooling needs by 10 percent - 20 percent in many climates.[8]
Solar water heating	Reduces the amount of energy required to heat water	A solar water heater can reduce natural gas consumption by 40-70 percent.[9]
Photo voltaic systems for buildings	Solar PV systems do not reduce energy use but reduce demand for electricity, and therefore reduce consumption of fossil fuels and production of greenhouse gases	Typically sized photovoltaic systems save over 50 percent of a buildings' electrical energy use.[10]
B.1.4 Retrofitting Residences		
Energy efficiency improvements in residences	Reduces energy needed by residential buildings	Energy efficiency retrofits of multi-family residential buildings can reduce building energy usage between 10-30 percent.[11]
B.1.5 Retrofitting Commercial Buildings		
Energy efficiency improvement in commercial buildings	Reduces energy needed by commercial buildings	One study of energy conservation retrofits in over 1,700 commercial buildings throughout the country found that median energy savings represented 18 percent of the energy use of the whole building.[12] Savings will probably be lower for California's newer buildings and for buildings that have already done some energy efficiency upgrades.
B.1.6 Efficient Lighting		
Efficient lighting	Reduces energy needs associated with lighting Reduces cooling needs (more efficient lighting generates less heat)	Use of new lighting technologies can reduce lighting energy use in homes by 50 to 75 percent, reducing total electricity use by about 8 to 12 percent.[13] ENERGY STAR qualified LED lighting uses at least 75 percent less energy and lasts 35 times longer than incandescent lighting.[14] Cooling demand will be reduced in a building with more efficient lighting because less heat is produced. Reducing lighting wattage in a commercial building by 50 percent can reduce cooling demand by about 19 percent.[15]
B.1.7. Shade Trees		
Shade trees	Reduces amount of energy needed by buildings	Properly placed trees can reduce building heating and cooling needs by 25 percent.[16]

Calculators

The **Database for Energy Efficient Resources (DEER)** is a California Energy Commission and California Public Utilities Commission (CPUC) sponsored database designed to provide well-documented estimates of energy and peak demand savings values, measure costs, and effective useful life (EUL) all with one data source. The users of the data are intended to be program planners, regulatory reviewers and planners, utility and regulatory forecasters, and consultants supporting utility and regulatory research and evaluation efforts. DEER has been has been designated by the CPUC as its source for impact costs for program planning. To obtain the DEER go to: http://www.deeresources.com (User ID: DEER, Password: 2008).

The **Climate and Air Pollution Planning Assistant (CAPPA)**, created by ICLEI, calculates the greenhouse gas and air pollution reduction benefits of a variety of strategies including building efficiency strategies. Building strategies available in the tool include: green building; efficiency loans; weatherization; building retrofits; and others. Calculations are based on assumptions and user-defined inputs. http://www.icleiusa.org/action-center/tools/decision-support-tool

The **Green Point Rated Calculator**. The GreenPoint Rated Climate Calculator, developed by Build it Green and StopWaste.Org, presents a methodology for calculating GHG emissions reductions for a green home compared to a conventional home. Cities and counties can use the calculator to determine GHG emission reductions from new construction of green homes in their local jurisdiction. Values in the calculator may not be specific to California. http://www.stopwaste.org/docs/calculator_report-spring_09_update.pdf

Tree Carbon Calculator. The Center for Urban Forest Research Tree Carbon Calculator for California climate regions estimates carbon storage and sequestration values for a tree plus the associated energy conservation and emission reductions. http://www.fs.fed.us/ccrc/topics/urban-forests/ctcc

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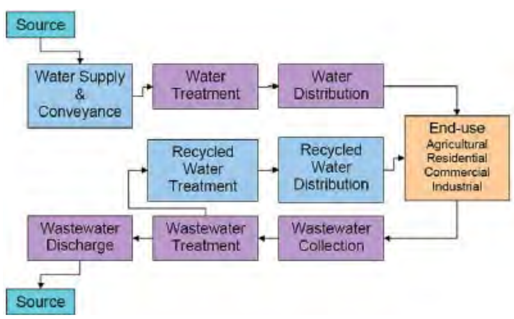
ENERGY AND GREENHOUSE GAS REDUCTION ESTIMATES

The tables in this section provide information that may be helpful in the calculation of the energy and greenhouse gas reduction benefits of the strategies in the *Water* section of the guidebook. In some cases, calculators may be available to assist (see Calculators below).



Source: California Energy Commission, *California's Energy-Water Relationship*

How much energy is associated with water use?
Energy is used in the conveyance, treatment, and distribution of water. The figure on this page[1] presents a schematic of the water use cycle in California.

The California Energy Commission has estimated that water accounts for 19 percent of all electricity consumed in the state and 30 percent of non power plant–related natural gas use.[1] Table 1 provides more detail on the amount of energy use associated with different stages of the water use cycle.

Table 1. Energy Associated with Water Supply, Conveyance and Treatment for Indoor and Outdoor Uses in California. [2]

Energy Aware Strategies	INDOOR (kWh / gallon)		OUTDOOR (kWh / gallon)	
	Northern CA	Southern CA	Northern CA	Southern CA
Water Supply and Conveyance	0.002117	0.009727	0.002117	0.009727
Water Treatment	0.000111	0.000111	0.000111	0.000111
Water Distribution	0.001272	0.001272	0.001272	0.001272
Wastewater Treatment	0.001911	0.001911	0	0
Regional Total	0.005411	0.013021	0.0035	0.01111

How do the water strategies in the Energy Aware Planning Guide reduce energy use?

Strategies in the guide reduce the energy use from water either by:

» Directly reducing the energy needed to pump, treat, or transport water (e.g. by improving the efficiency of pumps at water treatment facilities or by switching to less-energy intensive sources of water).

» Reducing the amount of water that must be pumped, treated, or transported (e.g. by reducing residential water demand or the amount of stormwater that must be treated).

How can I estimate energy savings and greenhouse gas reductions from the water strategies?

For strategies that directly reduce the amount of energy needed to pump, treat, or transport water, the major analytical steps are:

1. Use your billing or metering information, to determine or document the amount of energy currently used and the amount of water pumped, treated and transported.

2. Estimate the amount of energy that would be used to treat the same amount of water if the energy-efficiency measure(s) were put in place (e.g. a more efficient pump at a wastewater treatment site). That information may be available from product manufacturers or from already completed studies or audits.

3. Estimate the energy savings associated with the energy-efficiency measure (subtract #2 from #1).

4. Convert the energy savings into greenhouse gas reductions using the conversion factors provided in Appendix A (e.g. typical amount of greenhouse gases produced per unit of energy).

For strategies that reduce the amount of water that must be pumped, transported, or treated, the major analytical steps are:

1. Estimate the amount of water currently used for the purpose of interest (e.g. amount used in outdoor irrigation for residential homes). If available, use billing/metering information from water or wastewater agencies.

2. Estimate the amount of water that would be used if the water efficiency measure were put in place (e.g. amount used to irrigate if landscaping was converted to drought-resistant plants).

3. Estimate the water savings associated with the energy efficiency measure (subtract #2 from #1) and convert the resulting water savings into an estimate of energy using the conversion factors provided in Appendix A (e.g. typical energy savings per gallon of water).

4. Convert the energy savings into greenhouse gas reductions using the conversion factors provided in Appendix A (e.g. typical amount of greenhouse gases produced per unit of energy).

Table 2 below provides some relevant facts that may be helpful in calculating the energy reduction benefits from the water strategies in the guide.

Calculators

Green Values Stormwater Management Calculator (GVSMC) calculates the average annual and peak stormwater discharge from a development area of a user-defined size and type. The user also specifies the extent to which stormwater retention techniques such as native landscaping, roof drains, and porous pavements are used. Created by the Center for Neighborhood Technology. http://logan.cnt.org//calculator/calculator.

ICLEI's **Climate and Air Pollution Planning Assistant** (CAPPA) calculates the greenhouse gas and air pollution reduction benefits of a variety of strategies using assumptions and user-defined inputs. Those most relevant to this section include water ordinances; efficiency improvements to wastewater treatment systems; efficient landscaping; irrigation systems; and efficient toilets, showers and faucets. http://www.icleiusa.org/action-center/tools/decision-support-tool.

Table 2. Energy Aware Strategies – Relevant Facts

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
W.1.1 Stormwater		
Pervious pavements	Reduces amount of stormwater that must be pumped and reduces energy needed to treat stormwater (cleaner water takes less energy to treat)	One study found installation of pervious pavement reduced runoff 90 percent during small storms. Benefits are not as great during heavy storms.[3] One study found that a parking lot paved with porous concrete and bio-swales was 75-92 percent efficient at removing five types of metals from stormwater, compared to 23-59 percent efficiency for asphalt pavement with swales.[4]
Bioretention areas	Reduces amount of stormwater that must be pumped and reduces energy needed to treat stormwater (cleaner water takes less energy to treat)	Properly designed and constructed bioretention cells can reduce the quantity of certain heavy metals by as much as 90 percent.[5]
Green roofs	Reduces amount of stormwater that must be pumped and reduces energy needed to treat stormwater (cleaner water takes less energy to treat)	Green roofs can retain 60 -100 percent of stormwater they receive.[6]
W.2.1 Water Efficient Landscaping		
Water efficient landscaping	Reduces demand for water Reduces fuel used to maintain land-scape (e.g. through mowing)	Nationwide, landscape irrigation is estimated to account for almost one-third of all residential water use.[7] A study in Nevada found that changing from turf to xeriscaped yards (landscapes that do not need supplemental water) resulted in a 30 per-cent reduction in water use.[8] Converting to a water-efficient landscape through proper choice of plants and careful design can reduce outdoor water use by 20 to 50 percent.[9]
W.2.2 Water Pricing		
Water pricing	Reduces demand for water	On average, in the U.S. a ten percent increase in the marginal price of water can be expected to diminish demand in the urban residential sec-tor by about 3-4 percent. (This is equivalent to saying that U.S. residential water price elasticity is in the range of –0.3 to –.4).[10] Elasticities may differ depending on the type of use (e.g. price has much less effect on demand for essential water uses, such as drinking water). In general, price elasticity estimates in the industrial sector tend to be somewhat higher than residential elasticities, and they vary substantial-ly by industry. One study of 120 U.S. municipalities estimated industrial elasticities in the range of –0.44 to –0.97.[11]

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
W.3.1 Water Reuse		
Graywater reuse	Reduces demand for highly-treated water	Water that is reused in a graywater system eliminates the need to pump and treat an equivalent amount of new potable water for the site, and augments existing local resources eliminating the need to import additional supplies. Therefore, the amount of graywater reused can be directly converted into energy savings by multiplying the number of gallons re-used by the typical amount of energy used to pump and treat water (available in Appendix A).
Wastewater recycling	Reduces demand for highly-treated water	Water recycling uses energy to pump, treat and re-release the water into a purple pipe system. Therefore this strategy only confers energy reduction benefits if water recycling uses less energy than treating another source of water. Benefits are typically greatest if recycled water is used for outdoor uses, for which the level of water treatment is less than for drinking water.
W.4.1 Efficient Wastewater Treatment		
Replace pumps used at wastewater treatment facilities	Reduces energy needed to pump wastewater through treatment facility	The California Energy Commission estimates that about 2,500 kWh of energy are consumed for every million gallons of water treated at a prototypical wastewater treatment facility.[12] Variable-frequency drives can reduce a pump's energy use by as much as 50 percent. A variable frequency drive controlling a pump motor that usually runs less than full speed can substantially reduce energy consumption over a motor running at constant speed for the same period.[13]

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ENERGY AND GREENHOUSE GAS REDUCTION ESTIMATES

The tables in this section provide information that may be helpful in the calculation of the energy and greenhouse gas (GHG) reduction benefits of the strategies in the *Community Energy Strategies* section of the guidebook. In some cases, calculators may be available to assist (see Calculators, below).

How can I estimate energy savings and GHG reductions from the Community Energy Strategies?

The *Community Energy Strategies* differ from strategies in other sections in that they cover a variety of topical areas. There is no single analytical framework for estimating the energy reduction or GHG reduction benefits of the strategies. Table 1 provides facts that may be useful in quantifying benefits.

Calculators

ICLEI's **Climate and Air Pollution Planning Assistant** (CAPPA), in Microsoft Excel, calculates the greenhouse gas and air pollution reduction benefits of a variety of strategies based on assumptions and user inputs. Those most relevant to this section include reflective roofs; solar photo voltaic systems; green energy purchases; hybrid vehicles; small vehicles; retiring old vehicles; composting; and recycling. Many other strategies are provided. http://www.icleiusa.org/action-center/tools/decision-support-tool.

The U.S. Environmental Protection Agency (EPA)'s **Recycled Content Tool (ReCon)** in web-based and Microsoft Excel formats, was developed to help businesses and individuals calculate the greenhouse gas savings of purchasing recycled products with varying degrees of postconsumer recycled content. http://www.epa.gov/climatechange/wycd/waste/calculators/ReCon_home.html.

The Environmental Protection Agency's **Waste Reduction Model (WARM)**, in web-based and Microsoft Excel formats, was developed to assist solid waste managers in determining the GHG impacts of their waste management practices. WARM compares GHG and energy impacts of landfilling, recycling, incineration, composting, and source reduction. http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html.

The Northeast Recycling Council's **Environmental Benefits of Source Reduction, Reuse and Recycling Calculator** (in Microsoft Excel) estimates and compares the energy and emissions effects of alternative waste management strategies. The Calculator is based on per ton figures of the estimated energy use and emissions (including carbon emissions) from several lifecycle analysis studies. The estimates are average figures based on "typical" facilities and operating characteristics existing in the United States. http://www.nerc.org/documents/blank_nerc_calculator.xls.

Table 1. Energy Aware Strategies - Relevant Facts

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
C.1.1 Community Energy Authorities		
Community energy authorities	This strategy does not directly affect energy use	Formation of community energy authorities can support municipalities taking a more proactive role in managing energy supplies.
C.1.2 Energy District Financing		
Energy district financing	This strategy does not directly affect energy use	Energy district financing, authorized through AB 811, supports municipalities in financing renewable energy and energy efficiency projects.
C.1.3 Cool communities		
Reflective surfaces / roofs	Reduces building heat and cooling demand	Reflective surfaces, especially those used on roofs, can help reduce cooling demand by 10 – 15 percent [1] A reflective membrane installed on the roof of a 100,000 square foot building in Texas reduced total air-conditioning energy use by 11 percent and peak air-conditioning demand by 14 percent.[2]
Cool pavements	Reduces building cooling demand by reducing surrounding air temperature	Use of lighter color pavements can reduce surrounding air temperatures. One study found that an increase of pavement albedo (reflectivity) from 0.1 to 0.35 across an entire city would decrease air temperature of about 0.6°C (1°F), an energy savings of about $0.012 per meter-squared of pavement per year.[3]
Green roofs	Reduces building heat and cooling demand	Green roofs act as insulators, helping to cool the building in summer and keep it warm in winter. Energy reduction benefits are greatest during hot summer months in warm climates. For example, a comparison of several small buildings in Pennsylvania found those with green roofs used about 10 percent less electricity during the month of August than buildings with flat black roofs.[4]
C.2.1 Renewable energy		
Renewable energy	Renewable energy projects do not reduce energy use, but can reduce greenhouse gases	Use of renewable sources for a given unit of energy removes the equivalent amount of carbon dioxide that would have been produced by obtaining the energy from electricity or natural gas. Values for the amount of carbon dioxide avoided by using less electricity and natural gas are available in Appendix A.
C.2.2 Distributed generation		
On site generation	On-site generation does not reduce energy use (other than avoiding energy losses associated with transmission) but can reduce greenhouse gases	Use of renewable sources for a given unit of energy removes the equivalent amount of carbon dioxide that would have been produced by obtaining the energy from electricity or natural gas. Values for the amount of carbon dioxide produced from electricity and natural gas are available in Appendix A.
Combined heat and power	Reduces energy use by improving fuel efficiency	Integrated systems for Combined Heat And Power can increase the efficiency of energy utilization to as much as 85 percent (compared to about 35 percent for conventional systems) and save about 40 percent of the input energy required by conventional systems.[5]

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
C.3.1 Local Food		
Local food	Reduces the energy associated with transporting food over long distances	The average American meal travels 10,000 miles.[6] This figure is likely less for California, an agricultural state. An estimate of the energy reduction benefits of increasing consumption of local food would need to compare the gallons of fuel expended for a conventional diet versus one based primarily on locally-available foods.
C.4.1 Solid Waste		
Minimize waste creation	Minimizing waste reduces the amount of energy required to transport and dispose of waste materials; re-use of materials reduces the energy used to create new materials.	The largest single type of household waste in California is organic waste (representing 49 percent of waste), which can be composted. If one-third of the households composted one-half of that waste, eight percent of the total household waste will be diverted from the local landfill. With this reduction, one out of every 13 trips to the landfill can be eliminated. The absolute energy savings would depend upon how far the landfill is located from residences.[7]
Recycle waste material	Use of recycled products may reduce energy use if the recycled content can be produced with less energy than new content	In 2006, the amount of potentially recyclable materials from businesses with 100 or more employees (i.e., about 24,000 out of the 2,000,000 commercial businesses), combined with multifamily complexes consisting of more than five units and mobile home parks, totaled over 10 million tons. Of this amount, cardboard, lumber, glass, plastic, paper and metals constituted approximately 5.5 million tons. If these selected businesses and multifamily complexes were able to divert half of these waste materials (i.e., 2.7 million tons), this would realize estimated GHG emissions reductions of over 5 MMTCO2e per year.[8]
C.5.1 Municipal procurement		
Municipal procurement	Municipal purchase of recycled / re-used products can reduce the energy use associated with purchasing Municipal purchase of renewable sources of energy does not reduce energy use but reduces greenhouse gas emissions	The amount of energy saved by purchasing recycled products depends on the type and quantity of material being recycled. Calculators are available to estimate the energy savings and greenhouse gas reductions from purchasing recycled products (see Calculators below).
C.5.2 Municipal facilities		
Municipal facilities	Varies	This strategy describes how municipal governments can reduce the energy consumed by municipal facilities by using strategies discussed in other strategies such as W.2.1 Water Efficient Landscaping or B.1.6 Lighting.

Energy Aware Strategies	Energy Reduction Mechanism	Relevant Facts
C.5.3. Municipal fleet fuel efficiency		
Reduce mileage driven by vehicle fleet	Reduces gallons of fuel consumed by fleet vehicles	Reduced mileage driven by vehicle fleets translates directly into energy savings. Reductions in vehicle miles traveled can be translated into fuel savings and carbon dioxide reductions using the emissions factors in Appendix A.
Optimize driving	Reduces gallons of fuel consumed by fleet vehicles	Aggressive driving (speeding, rapid acceleration and braking) wastes gas. It can lower gas mileage by 33 percent at highway speeds and by five percent around town.[9]
Improve vehicle fleet maintenance	Reduces gallons of fuel consumed by fleet vehicle	Fixing a car that is noticeably out of tune or has failed an emissions test can improve its gas mileage by an average of four percent, though results vary based on the kind of repair and how well it is done. Fixing a serious maintenance problem, such as a faulty oxygen sensor can improve mileage by as much as 40 percent.[10] Keeping tires inflated to the proper pressure can improve gas mileage by around 3.3 percent.[11] Using the manufacturer's recommended grade of motor oil can improve gas mileage by 1-2 percent.[12]
Improve fleet fuel efficiency	Reduces gallons of fuel consumed by fleet vehicles	Improvements in vehicle fuel efficiency translate directly into fuel savings.

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SECTION III

MEETING CALIFORNIA'S CLIMATE CHANGE CHALLENGE

ENERGY AWARE PLANNING GUIDE

STATE GREENHOUSE GAS REDUCTION REQUIREMENTS

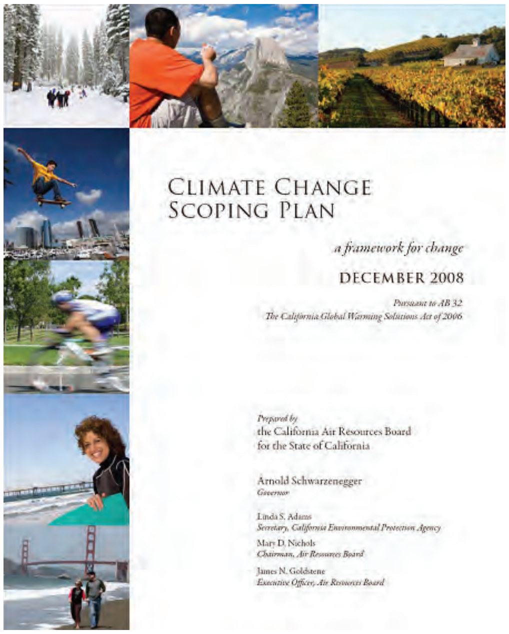
California is particularly vulnerable to the potential impacts of climate change. Projected increases in temperature and precipitation changes, increased transmission of infectious diseases, and higher air pollution levels could significantly impact public health and mortality rates in our large and aging population. California's coastline communities and wetlands could suffer extensive and irreversible damage as sea levels rise over the next century. Our $30 billion agriculture industry could be impacted by new temperature and rainfall patterns and the increased pests and diseases that may accompany those changes. California's water supply is already facing challenges, in part from the shrinking snowpack in the Sierra Nevada mountains. This, the state's largest reservoir, is predicted to lessen by one third over the next 50 years, and to halve its historic size by the end of the century. The state has taken action to combat climate change through legislation including the Global Warming Solutions Act (AB 32) which sets a goal of reducing the state's carbon emissions; SB 375, which sets regional targets for the purpose of reducing greenhouse gas (GHG) emissions from passenger vehicles; and SB 97, which calls for amendments to the California Environmental Quality Act (CEQA) Guidelines for GHG emissions.

State officials have identified transportation as the largest single source of GHG emissions, accounting for 38 pecent of the statewide total. The electricity and commercial/residential energy sector is the second-largest source of emissions. Both sources are significantly influenced by local government land use decisions. This gives local government officials both the opportunity and the responsibility of playing a key role in achieving the state's GHG reduction targets. This section provides descriptions of these key pieces of climate change legislation as they relate to local governments:

AB 32: The CA Global Warming Solutions Act Of 2006

In 2005, Governor Arnold Schwarzenegger issued an Executive Order establishing ambitious GHG reduction targets for the state. The targets included reducing GHG emissions to 2000 levels by 2010, reducing emissions to 1990 levels by 2020, and reducing emissions to 80 percent below 1990 levels by 2050. While only binding for state agencies, the Executive Order does obligate them to implement GHG reduction strategies.

The legislature took action the following year. AB 32, the Global Warming Solutions Act of 2006, directs the California Air Resources Board (ARB) to reduce the State's global warming emissions to 1990 levels by 2020. The statute required ARB to adopt a plan for meeting GHG reduction targets (Scoping Plan) by the end of 2008, and required that regulations to implement the Scoping Plan be enforceable by 2012.



The California Air Resources Board Scoping Plan is California's plan for meeting its greenhouse gas reduction goals.

The Scoping Plan sets out eighteen recommended action areas for meeting emissions targets. The action areas most relevant to the strategies in this guidebook are:

1. Energy Efficiency;
2. Regional Transportation-Related GHG Targets;
3. Million Solar Roofs Program;
4. Recycling and Waste; and
5. Water.

Some of the actions will be implemented by state agencies, while others will require local government involvement. Local governments are essential partners in implementing the Scoping Plan strategies and ensuring progress towards GHG reduction goals.

For current information on AB 32, the Scoping plan, the timeline and tracking implementation, visit: http://www.arb.ca.gov/cc/scopingplan/scopingplan.htm.

"Local governments are essential partners in achieving California's goals to reduce greenhouse gas emissions. They have broad influence and, in some cases, exclusive authority over activities that contribute to significant direct and indirect greenhouse gas emissions through their planning and permitting processes, local ordinances, outreach and education efforts, and municipal operations. Many of the proposed measures to reduce greenhouse gas emissions rely on local government actions."

—ARB Scoping Plan, 2008

SB 375: Addressing Greenhouse Gas Emissions From Transportation And Land Use

SB 375, the Sustainable Communities and Climate Protection Act of 2008, supports the Scoping Plan goals relating to reducing GHG emissions from the transportation sector through land use changes and other policies. It fosters coordination between regional transportation planning processes and local government strategies to reduce GHGs from transportation, and sets a framework for meeting regional GHG reduction targets through land use changes and other policies implemented at the local level. The following are the basic requirements of SB 375:

1. ARB will establish regional targets for reductions in GHG emissions from passenger cars and small trucks that are associated with land use decisions.

2. Metropolitan planning agencies (MPOs) will develop and include a Sustainable Communities Strategy (SCS) in their Regional Transportation Plans (RTP) that meets the ARB reduction targets only if feasible to do so. The SCS is the MPO's plan to achieve the GHG emissions from automobiles and light trucks in the region. If the MPO is not able to meet ARB's target through the SCS, they must prepare an Alternative Planning Strategy (APS) showing how the targets would be achieved through alternative development patterns, infrastructure, or additional transportation measures or policies.

3. Funding decisions for regional transportation projects will be internally consistent with the RTP.

4. The Regional Housing Needs Assessment (RHNA) process will be aligned with the RTP to assure that the Sustainable Communities Strategy takes population growth and the associated housing needs into account for all economic segments.

5. Certain projects that are consistent with the SCS or an APS – whichever actually meets the target – will receive some relief from California Environmental Quality Act (CEQA) requirements. For instance, residential and mixed-use residential projects consistent with an SCS or APS are not required to: consider the impacts of passenger vehicle trips generated on global warming; discuss either project-specific or cumulative impacts on the regional transportation network; or consider their growth-inducing impacts.[1]

ARB is required to assign MPO targets by September 2010. A Regional Targets Advisory Committee was created to develop the target with input from regions and other stakeholders. After the regional goals are established, regional transportation plans must include a Sustainable SCS that will show how the goal will be met, or else develop an APS that identifies barriers to meeting the targets.

CEQA Guidelines Related To Greenhouse Gas Reduction

In 2007 the state legislature mandated that the Governor's Office of Planning create CEQA guidelines addressing GHG emissions through SB 97. In advance of these guidelines the state Attorney General initiated a law suit against San Bernardino County on the grounds that the County's general plan violates AB 32 and CEQA, respectively, in failing to consider ways to reduce GHG emissions and to evaluate the general plan's impacts on global warming. To date, the Attorney General has questioned the proposed draft environmental impact reports of several general plans over the need to evaluate GHG reduction impacts under CEQA, including Stockton, San Diego, Solano County, Tulare County, as well as regional transportation plans, re-

Smart Growth Energy and New Attitudes?

Californians have been debating how and where to grow for decades: growth control, growth management, local initiatives and referenda, saving farmland, ecosystem health, litigation and now smart growth. Regardless of the name, the issues have never had more currency and relevance than they do today, with the need to save energy, reduce carbon emissions, and support healthy lifestyles for kids and adults alike. The stakes have been raised; the benefits of smart growth go way beyond saving farmland.

Thinking differently about land use gives us the opportunity to gain many co-benefits. We can improve our health and well being by walking more to school, to the store and to the neighborhood coffee shop and breathing cleaner air when we do. We can reduce the personal costs of automobile use and reduce carbon emissions at the same time, with smaller cars, higher mileage, and fewer short trips in our own neighborhoods. AB 32 and SB 375 set goals and give parameters for change in every part of the state. Neither of them would have been possible without leadership supported by broad public concurrence. Builders, automakers, educators and businessmen are responding to growing awareness and concern across all levels of society. Kids in the valley have asthma rates that are alarmingly high. Californians have unprecedented rates of obesity and diabetes, and the escalating cost of fossil fuel makes driving a car a bigger expense for everyone.

Californians care about their environment. Clean air and clean water, healthy lifestyles and different kinds of housing for our increasingly diverse

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and complex population have great public support. Not just more regulations, there are incentives and opportunities to improve our cities, and earn public support at the same time.

SB 375 is not mandatory, but cities and counties across the state are going "green" and looking for ways to become more sustainable. There are several different ways to meet the goals of the law and while achieving greater sustainability and fewer emissions.

Applying a fresh set of criteria to new green field development is relatively easy. Small increases in density, providing a variety of housing choices, apartments and townhouses as well as traditional subdivisions will produce big results in moving California closer to its goal. But markets are slow in the current economy, and the achievement of new development of any significance is likely ten years or more away.

The greatest opportunities in the short term are for infill and redevelopment, and it is possible to work with developers to infuse new ideas into existing entitlements.

Infill and redevelopment possibilities exist in every city. Granny flats, finding and using vacant property, raising single story neighborhoods to two or three stories, converting abandoned or vacant commercial properties into apartments, lofts and condos, and building clustered housing around transit stops will provide needed housing. The solutions will be different in large cities and small, but there are new ideas and a new reality. Working with developers, some planners are compiling lists of innovative ways to adapt existing entitlements to meet SB375 goals, like opening up cul de sacs, allowing grocery stores and small scale retail to be built in residential zones, reducing the minimum parking requirements and providing walk and bikeways throughout subdivisions and existing developments. All the components of good communities have to be addressed as we work to achieve our targets. Good schools, safe streets and public amenities are vital parts of any strategy. I am confident the new realities created by a changing environment, greater public consciousness, and new laws will enable California to maintain its leadership, protecting the environment and providing a good quality of life for all its residents.

Carol Whiteside
Founder and President Emeritus
Great Valley Center

The Sustainable Community Strategy versus the Alternative Planning Strategy

The Institute for Local Government Web Site provides the following concise description of the requirements of a Sustainable Communities Strategy (SCS) versus an Alternative Planning Strategy (APS):

"The SCS is a growth strategy for the region which, in combination with transportation policies and programs, strives to reduce greenhouse gas emissions and, if it is feasible, help meet [ARB's] targets for the region.

Specifically, a Sustainable Communities Strategy will:

» ***Identify the general location of uses, residential densities, and building intensities within the region;***

» ***Identify areas within the region sufficient to house all the population of the region, including all economic segments of the population, over the course of the planning period of the regional transportation plan;***

» ***Identify areas within the region sufficient to house an eight-year projection of the regional housing need for the region;***

» ***Identify a transportation network to service the transportation needs of the region;***

» ***Gather and consider the best practically available scientific information regarding resource areas and farmland in the region;***

» ***Set forth a forecasted development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce greenhouse gas emissions from automobiles and light trucks to achieve, if there is a feasible way to do so, the greenhouse gas emissions reductions target approved by the state board; and***

» ***Quantify the reduction in greenhouse gas emissions projected to be achieved by the SCS and, if the SCS does not achieve the targeted reductions in greenhouse gas emissions, set forth the difference between the amount that the SCS would reduce greenhouse gas emissions and the target for the region.***

If the Sustainable Communities Strategy will not achieve the region's greenhouse gas reduction target, the region must also prepare a separate document called the 'Alternative Planning Strategy.' Projects consistent with this strategy also qualify for CEQA incentives."

The Alternative Planning Strategy is a separate document (not included in the Regional Transportation Plan), which does not affect the distribution of transportation funds. It must identify impediments to achieving the greenhouse gas reduction targets included with the Sustainable Community Strategy.

fineries, cement plants, dairy expansions, and other large projects. Cities should plan incorporate climate change mitigation and adaptation in their planning efforts in advance of action from the state.

Enacted in 2007, SB 97 required the Governor's Office of Planning and Research (OPR) to develop draft CEQA guidelines "for the mitigation of greenhouse gas emissions or the effects of greenhouse gas emissions."[2] OPR submitted to the California Secretary for Natural Resources its proposed amendments to the state CEQA Guidelines for GHG emissions, as required by SB 97. These proposed CEQA Guideline amendments would provide guidance to public agencies regarding the analysis and mitigation of the effects of GHG emissions in draft CEQA documents. The Resources Agency must certify and adopt the guidelines on or before January 1, 2010.

What Do The CEQA Guidelines Require?

Public Resources Code section 21083.05 suggests that GHG emissions and their effects are appropriate subjects for CEQA analysis. Public agencies must address the potential environmental effects of GHG emissions from projects subject to CEQA. Agencies are required to identify a project's potentially significant effects on the environment, and to mitigate significant effects whenever feasible.[3]

For current information on the CEQA guidelines:

California Natural Resources Agency
http://ceres.ca.gov/ceqa/guidelines.

Attorney General's Office:
http://ag.ca.gov/globalwarming/ceqa/generalplans.php.

How Do These Requirements Relate To The Energy-Aware Planning Guide?

Strategies in the Energy Aware Planning Guide can be used by cities and counties in general plans and local Climate Action Plans and should be consistent with the region's Sustainable Community Strategy or Alternative Planning Strategy to contribute to regional GHG emission reduction targets. The transportation and land use measures can directly reduce emissions from vehicle use. The efficiency measures in the other sections – buildings, solid waste and water use – will reduce emissions indirectly by reducing energy consumption and emissions from power plants and the combustion of natural gas.

More Resources

Office of the Attorney General- State of California
http://ag.ca.gov/globalwarming/ceqa/generalplans.php

ARB's Local Government Toolkit
http://coolcalifornia.org

Local Government Commission
http://lgc.org/issues/climatechange.html

Endnotes

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ADAPTATION PLANNING

What is Adaptation Planning?

In spite of our best efforts to avoid the effects of climate change, some climate change impacts are occurring now and will increase in intensity in the future. Government agencies need to plan for how they will adapt to these impacts.

Scientists are in agreement that the climate is changing at an alarming rate. Some current projections show global average temperature increases of between 3º F and 10º F over the next 90 years, with warming expected to be even higher in the United States.[1] Climate change will have profound consequences for California, and impacts are already being felt across the state. During the last century, the average spring snowpack in the Sierra Nevada mountains has decreased by 10 percent (a loss of 1.5 million acre-feet) and sea levels have risen seven inches along California's coast, increasing erosion and pressure on the state's infrastructure, water supply, and natural resources. Southern California cities have experienced their lowest recorded annual precipitation twice in the past 10 years.[2]

The California Natural Resources Agency has recently completed a draft of the ***2009 California Climate Adaptation Strategy***, which lays out a state-level plan for combating the effects of climate change. However, much of the burden of mitigating climate change impacts will be up to municipalities.

Scientists have identified a number of climate change impacts that have significant implications for local governments, including:

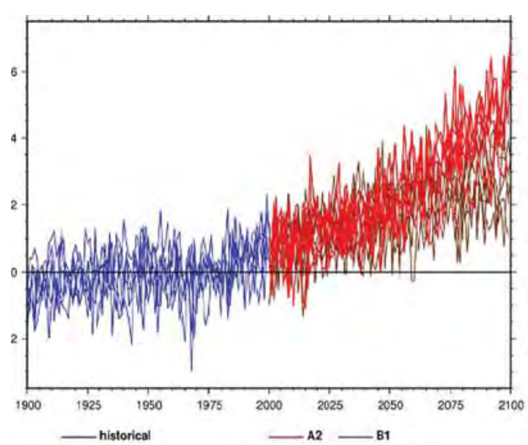
» *Increased temperatures* that can damage infrastructure and reduce water levels in inland waterways;

» *Volatile precipitation* that can damage infrastructure and impact soil condition;

» *Rising sea levels* that can impact coastal communities, bays, estuaries and deltas;

» *Extreme weather events,* which may impact infrastructure and operations; and

» *Public health impacts.*



Annual Temperature Projections for the Sacramento Area.
Source: California Energy Commission, 2009).

This section is intended to provide your jurisdiction with information on the effects of climate change, a list of resources your jurisdiction can use to plan for its impacts, and a number of potential municipal adaptation strategies that may be used to plan for and alleviate its adverse consequences.

Climate Change Impacts

There is now irrefutable scientific evidence that greenhouse gas emissions are changing the Earth's climates. Current warming trends are occuring faster than any time in the past 650,000 years. Eleven of the past twelve years (1995 to 2006) rank among the twelve warmest years in worldwide global surface temperatures since 1850.[3] Our rapidly changing climate is already resulting in significant alterations in temperature, precipitation, storm events, and other aspects of the climate in California. The following is a partial list of potential impacts California municipalities might expect to result from climate change:

Transportation and Infrastructure Impacts

» **Pavement damage.** More extreme summer temperatures and volatile precipitation could lead to rapid deterioration of highway pavement, causing increased cracking, potholes, and bleeding.[3] The degraded structural integrity of roads would result in safety concerns as well as higher and more frequent maintenance costs.

» **Rail buckling.** Higher temperatures may result in more frequent rail buckling, which can lead to increased maintenance costs and, if undiscovered, train derailments. Rapidly deteriorating rail systems may require lower speeds, shorter trains to limit braking distances, and lighter loads to lower stress on tracks.[4]

» **Bridge and port damage.** The expected service life of bridges or port facilities may be reduced requiring more frequent maintenance due to heat-cold, freeze-thaw cycles and in extreme cases may force retrofitting or expensive reconstruction.[5]

» **Reduced inland waterway levels.** Lower water levels would require waterborne commerce to lighten cargo loads or governments to invest in the costly re-dredging of passages. Dredging of waterways may have unintended negative environmental impacts – dredging often stirs up harmful highly contaminated dredged material.[6]

» **Flooding.** Increased storm activity and intensity may also lead to storm surge flooding, coastal erosion and severe infrastructure damage, the effects of which could be exacerbated by a rise in sea level. Rural and coastal areas would be particularly at risk.[7]

» **Rising sea levels.** Higher sea levels could have impacts on low-level roads, ports, and coastal property. Many coastal communities may have arterial roads in low-lying areas – these would be the first to flood in the event of higher sea levels.[8] Utility services may also be affected.

Water Impacts

» **Reduced snowpack in higher elevations.** The majority of California's fresh water supply originates in the Sierra Nevada snowpack, which provides an average of 15 million acre-feet of water. The Department of Water Resources has estimated that the Sierra snowpack will experience a 25-40 percent reduction from its historical average by 2050, severely limiting the availability of fresh water across the state.[9]

» **Higher Sea Levels.** Studies have estimated a rise of 7-55 inches along the California coast over the next 100 years.[10] This could negatively affect coastal communities, wastewater treatment plants, and cause catastrophic levee failures. The San Joaquin-Sacramento Delta, the hub of California's water supply and delivery system, could be deeply affected by saltwater intrusion caused by high sea levels. This would degrade drinking water, agricultural water, and ecosystem conditions.[11]

» **Droughts.** Higher temperatures and volatile rainfall and runoff will boost the frequency and intensity of droughts, particularly in regions that rely heavily on surface water, as evaporation rates escalate and water demand increases for agricultural and landscaping needs.

» **Floods.** High frequency flood events may increase due to more intense storms and changes in watershed vegetation and soil moisture conditions. This will lead to erosion changes that could increase sedimentation behind dams, affecting habitats and water quality.

» **Water Quality.** Changes in temperatures and the timing of river flows may adversely affect the quality of remaining water. Floods and erosion could increase the concentration of pollutants and threaten the integrity of water treatment infrastructure. Lower water flows may also lead to increased concentration of pollutants. Higher water temperatures would increase the growth of microorganisms in water supplies.[12]

» **Hydroelectric generation.** Volatile water flows would reduce the reliability of the state's largest source of very low greenhouse gas emission energy, hydroelectric power.

Energy Use Impacts

» **Increased Electricity Demand.** Increases in average temperatures and the increased frequency of extreme heat events will drive up demand for cooling in summertime.

» **Reduced Hydroelectric Power Resources.** Hydropower, which accounts for roughly 15 percent of in-state energy generation in California, is vulnerable to volatile precipitation as well as reduced snowpack, which is a major source for over half of the state's hydroelectric power.[13]

Agriculture Impacts

» **Variations in Crop Yields.** Volatile weather patterns and growing seasons may result in decreased or irregular crop yields.[14]

» **Pest and Weed Changes.** Temperature and precipitation changes may affect the impact of pests and weeds on California crops.[15]

Forestry Impacts

» **Timber Declines.** Some models have predicted a decline in the productivity of timberlands in the Sierra Nevada Mountains as a result of warming temperatures.[16]

» **Forest Fires.** Drier soils and forests would increase the frequency and intensity of fires.

» **Carbon Sequestration Effects.** Volatility in water supplies could result in a decline in the ability of trees to store carbon, which could magnify climate change effects.[17]

Public Health Impacts

» **Increased Air Pollution.** Higher temperatures may increase levels of key air pollutants such as ozone and particulate matter (PM), which depend strongly upon temperature levels in the lower atmosphere. Increased occurrence of wildfires contribute to poor air quality, which has been shown to cause increased cases of asthma and other respiratory conditions.

Possible Sea Level Rise Impacts in the Bay Area. One meter of sea level rise could inundate many low lying areas around the Bay, including the Oakland and San Francisco airports.
Source: Bay Area Conservation and Development Commission.

» **Increased Heat Waves.** Heat wave conditions correlate directly to cases of hyperthermia and dehydration, causing deaths in people over 65 years of age, outdoor workers, and people engaged in strenuous exercise. Costly hospitalizations and emergency room visits also increase during heat waves.

Climate Change Adaption Resources

Effectively addressing local climate change first requires the identification, assessment, and evaluation of local impacts. A wealth of information has been published to assist local jurisdictions in these efforts:

» California's statewide **Climate Adaptation Strategy** was launched to prepare for the expected impacts of climate change. The CAS is intended to coordinate adaptation planning with policies targeting greenhouse gas mitigation, and to provide an up-to-date resource for policy-makers on expected climate change impacts and possible alleviation strategies. Information available online at http://www.climatechange.ca.gov/adaptation/index.html.

» **The Intergovernmental Panel on Climate Change** (IPCC) is an international scientific body established by the United Nations for the purposes of assessing the current state of climate change and its potential environmental and socioeconomic consequences. The IPCC publishes scientific data on climate change and potential impacts, accessible at http://www.ipcc.ch.

» **The World Resources Institute** (WRI) is a nonprofit think tank that publishes useful information on climate change policies at the international, national, regional, and local levels. More information at http://www.wri.org/project/state-regional-climate-policy.

» **The International Institute for Sustainable Development** (IISD) is a nonprofit organization that promotes sustainable development policies including those aimed at reducing the impacts of climate change. More information available at http://www.iisd.org.

» The **U.S. Environmental Protection Agency** maintains an informational web site on steps that state and local governments can take to reduce the impacts of climate change in their communities at http://www.epa.gov/climatechange/wycd/stateandlocalgov/index.html.

» The **U.S. Department of Transportation** maintains the Transportation and Climate Change Clearinghouse, which provides useful information and links to existing documentation on climate change impacts as well as adaptation planning strategies. Available at: http://climate.dot.gov/impacts-adaptations.

» California's **Climate Action Team,** established to meet state GHG reduction targets, publishes the Climate Action Team Report, which includes detailed analyses of the climate change impacts that Californians are experiencing now and can expect to experience in the future. Available at http://www.climatechange.ca.gov/climate_action_team.

» **The California Climate Change Research Center** is operated as part of the California Energy Commission's Public Interest Energy Research Program (PIER). The center provides a number of resources for policy-makers including information on climate monitoring, analysis and modeling; greenhouse gas inventory methods; and adaptation planning. More information at: http://www.climatechange.ca.gov/research/index.html

» **CoolCalifornia.org** is a statewide public-private partnership aimed at providing climate impact reduction strategies to Californians. The site includes a Local Government Toolkit, which includes guidelines for conducting GHG inventories and modeling tools and resources for climate action planning. Available at http://www.coolcalifornia.org.

» **State of California Department of Water Resources** published Managing an Uncertain Future: Climate Change Adaptation Strategies for California's Water, a resource on water-related adaptation planning policies. Available on-line at: http://www.energy.ca.gov/2008publications/DWR-1000-2008-031/DWR-1000-2008-031.pdf.

» **The California Climate Action Network** (CCAN) was established by the Institute for Local Government to provide California municipalities with resources and tools to alleviate the impacts of climate change. The CCAN publishes a Best Practices Framework, which can be accessed at http://www.cacities.org/resource_files/26286.BestPracticesFramework%20v5.0.pdf. More information available at http://www.ca-ilg.org/climatechange.

» **ICLEI – Local Governments for Sustainability** is an international organization that provides resources such as training, consulting, and information services to local governments interested in preparing for climate change impacts. ICLEI has helped California cities such as Berkeley prepare adaptation sections of climate action plans. http://iclei.org.

Adaption Planning

Adaptation planning offers solutions to these and other climate impacts through careful planning and preparation, which is intended to take place alongside ongoing GHG emissions reduction efforts. Adaptation strategies are preventive measures aimed at alleviating negative climate change impacts more effectively and at lower cost, before they become crises. Cities that develop comprehensive adaptation plans, particularly in coordination with neighboring jurisdictions, will be more prepared for the adverse consequences of climate change.

The following are examples of broad adaptation strategies that could warrant inclusion in a local adaptation plan:

» Prepare for changing temperatures.

- Implement more heat-tolerant street and highway landscaping practices.
- Utilize heat-resistant paving materials.
- Shift construction schedules to cooler parts of the day.
- Relocate vulnerable sections of road and rail lines to more stable ground.[18]

Some of the strategies contained within the Community Energy Strategies section of this guide provide additional ideas on how to reduce heat generated from surfaces in urban areas.

» Improve flood control.

- Regionally coordinate existing water and flood management systems.
- Promote and practice integrated regional water and flood management.[19]
- Strengthen flood defense mechanisms, increase maintenance frequency, and potentially relocate transportation facilities in flood-prone coastal areas.[20]
- Construct barriers to protect against storm surges and prepare for alternate traffic routes in the event of increased storm intensity.[21]
- Elevate streets, bridges and rail lines.
- Elevate and protect bridge, tunnel and transit entrances and provide greater pumping capacity for tunnels.
- Strengthen and heighten existing levees and seawalls.
- Limit development in vulnerable coastal areas. Increased flood insurance rates may also deter such development.[22]
- Tighten bridge decks more securely to substructure and strengthen foundations.

- Address traffic bottlenecks on critical evacuation routes.
- Adopt modular construction techniques where infrastructure is in danger of failure.
- Develop modular traffic features and road sign systems.[23]

» Improve infrastructure management capacity.

- Analyze different climate change scenarios, including severe weather events (whether or not they are climate change related) and their potential impacts on infrastructure assets.
- Provide opportunities to prioritize capital improvements relative to the vulnerability and sensitivity of transportation systems to climate change.[24]
- Preserve, upgrade and increase sensors for the monitoring and data analysis of existing water resources.
- Improve modeling of emergency evacuation.

» Reduce water consumption.

- Implement water conservation measures in permitting and other proceedings.
- Adopt a Water Efficient Landscape Ordinance (required by 2010).
- Expand water storage practices.

Many of the strategies contained within the Water Use section of this guide provide additional detail on how to encourage efficient use of existing water resources.

» Improve water and wastewater efficiency.

- Cycle pumps to use the most efficient systems first.
- Adopt water efficiency landscaping principles.[25]
- Implement community-wide water conservation and reclamation programs.
- Promote Integrated Regional Water and Flood Management (IRWM). IRWM planning is a comprehensive framework for determining the appropriate mix of water demand and supply management options and water quality actions. If developed and implemented in conjunction with other regional planning efforts for transportation and land use, IRWM can be a powerful regional tool for climate change preparation. IRWM plans can incorporate:
  * An assessment of the region's vulnerability to long-term climate change risks.
  * A drought component that assumes, for instance, 20 percent increase in drought frequencies.
  * Aggressive water conservation and efficiency strategies.
  * Integration with land use policies to slow runoff and improve water quality.
  * Encouragement of low-impact development that reduces water demand and captures and reuses stormwater runoff.[26]

See Section VI of this guide for more strategies your jurisdiction can use to reduce energy consumption and GHG emissions. The 2009 California Climate Adaptation Strategy is available at http://www.climatechange.ca.gov/adaptation.

Programs in Operation

The city of Berkeley adopted its Climate Action Plan in 2009. The plan estimates Berkeley's current and projected GHG emissions and establishes a plan for reducing climate impacts through sustainable transportation and land use, building energy use, waste reduction, and community outreach. The plan is available at http://www.berkeleyclimateaction.org.

King County, Washington (Seattle) formed an interdepartmental climate change adaptation team in 2006 to ensure that climate change issues were considered in policy, planning and capital expenditure decisions. The county partnered with a non-profit research group to develop the 2007 King County Climate Plan, which lays out detailed goals and practices for six strategic focus areas: climate science, public health/safety/emergency response, water management and supply, land use and transportation, financial and economic impacts, and biodiversity and ecosystems. The full plan is available online at: http://www.metrokc.gov/exec/news/2007/pdf/climateplan.pdf.

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SECTION IV

FULLY INTEGRATED PLANNING

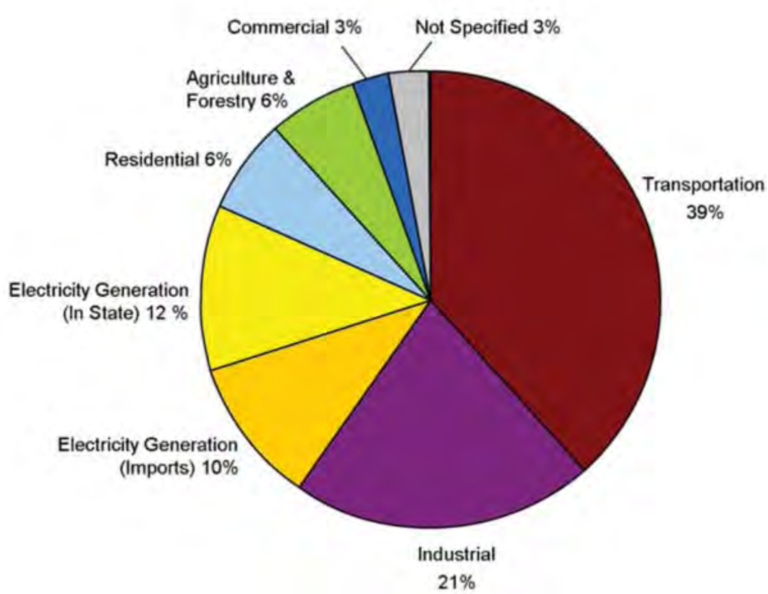
ENERGY AWARE PLANNING GUIDE

INTEGRATED REGIONAL PLANNING

Transportation (including passenger cars, light and heavy-duty trucks, rail and water conveyance) is the largest single source of greenhouse gas (GHG) emissions in the state, accounting for 39 percent of California's emissions. The amount of emissions coming from transportation is significantly influenced by local government land use decisions. Improvements in land use can result in a decrease in emissions, thereby improving air quality and combating climate change. This gives local government officials both the opportunity and the responsibility to play a key role in achieving the state's GHG reduction targets.

Why Cities, Counties, and Regional Governments Need to Work Together

Local governments have the ability to directly influence both the siting and design of new residential and commercial developments in a way that reduces GHGs from transportation, as well as energy and water use, and waste disposal. Regional governments control much of the funding and planning for major transportation projects, which need to be coordinated with local land uses. Regional governments are required under SB 375 to prepare a Sustainable Communities Strategy (SCS) in



2006 GHG emissions by Sector.
California Air Resources Board. 2006. State gross emissions totaled 483.9 million metric tons CO2e in 2006.

their Regional Transportation Plans (RTP) that meet GHG reduction targets.

State mandates on GHG reduction (see Section III: Meeting California's Climate Change Challenge for more information) require local governments to demonstrate how local land use changes and other strategies will support regional GHG reduction goals from the transportation sector. While local governments are not required to make their general plans or land use policies consistent with the SCS, voluntary local government adoption of the SCS into the general plan is critical to achieving GHG reduction goals. As the 2008 California Air Resources Board (ARB) Scoping Plan indicates, "state, regional, and local agencies must work together to prioritize and create the supporting policies, programs, incentives, guidance, and funding to assist local actions to help ensure regional targets are met."

Benefits of Coordination

The best reason for creating a viable Sustainable Communities Strategy that is fully integrated with local land use plans is the potential for reducing emissions associated with automobile use. To the extent that each region's SCS succeeds in fostering environments where alternatives to the automobile are viable (e.g., walking, bicycling, transit), additional benefits may include a healthier, more physically active population; cleaner air; reduced traffic congestion; reduced commute times, reduced infrastructure costs; reduced suburban sprawl, the preservation of open space, and an improved quality of life.

Integrated planning among these cities and metropolitan planning organizations (MPO) can have further benefits. Water supplies and economic development are both addressed most effectively on a regional level. The same is true for the preservation of the most valuable farmland or habitat.

Challenges Related to Integrating Local and Regional Planning

Local control of land use is a highly valued power of local government. As a result, some local government officials and community residents will resist any perceived interference with local land use decisions.

Local elected officials serve on the Boards of Directors of MPOs and have the power to direct policy. For an SCS to be successful, local officials must play a key role in its design.

The greatest successes have been achieved by MPOs that invest substantial resources to involve community residents, as well as elected leaders, in the visioning process. During tight budget times, however, this will be a barrier.

Funding is also crucial to translating the regional plan into local, on-the-ground projects. General plans may need to be rewritten to incorporate regional goals, and these general plan measures need to be translated into zoning changes. Outdated zoning codes present a significant barrier to building walkable, transit-oriented development.

Examples of Successful Integration

Prior to passage of SB 375, work was already underway in California to improve coordination between regional planning and local land use planning through the Blueprint Planning Program, which provides funding to conduct comprehensive scenario planning that results in a preferred growth scenario or "blueprint" for a 20-year planning horizon. While these blueprints offer strategies for reducing GHG emissions from passenger cars and small trucks through land use changes, they sometimes address additional issues such as public health, water, reduced nonrenewable energy dependence, the preservation of open space and agricultural land, and economic development. The preferred growth scenario and regional priorities chosen through the blueprint planning process can help regions inform their Sustainable Communities Strategies.

Statewide funding for Blueprint Planning emerged from work done in the **Sacramento** region by the Sacramento Area Council of Governments (SACOG) and others. SACOG adopted its Preferred Blueprint Scenario in December 2004. It is a bold vision for growth that promotes compact, mixed-use development and more transit choices as an alternative to low-density development. This was accomplished after an extensive public participation process that provided workshops in every city in the six-county region in addition to regionwide events.

The Preferred Blueprint Scenario formed the basis for land use patterns included in SACOG's 2035 RTP. Using strategic investment in the region's transportation infrastructure, the plan is expected to curb the growth in traffic congestion that each household experiences, protecting air quality while improving the quality of life.

The City of **Roseville**, as early as 2005, adopted strategies mirroring the Blueprint's smart growth principles. The city performed community outreach to encourage public awareness of the population growth faced by Roseville and to stress the value of Blueprint's 50-year plan of development. Among other measures, the City Council approved the Stonepoint project in early 2005: a high-density, mixed-use project that includes two 10-story towers, 225 high-density housing units, 350 medium-density housing units, and a two-acre park. Stonepoint differed radically from other development in the city, attracting some neighborhood opposition. However the elected officials that stood their ground were supported by the majority of residents.

Ten additional local governments in the region quickly followed Roseville's lead with general plan changes, new plans, and projects. They continue to receive assistance from the regional government with model codes and grants that help the cities and counties bring their planning documents up to speed. The Council of Governments (COG) also supports these efforts by offering a photo library, computer software, photo simulations, educational videos, and more.

Integrated Planning Beyond the Metropolitan Planning Organization

It is not unusual for developers to be forced to deal with competing planning requirements from different departments. In one instance, a planning department in a large city was preparing street tree requirements while their own public works department was cutting down trees.

It is especially vital that land use decisions be integrated with transportation decisions because the majority of GHG emissions come from the transportation sector, which is greatly effected by community design. According to Census data from 2005-2007, the average commute time for Californians was 27 minutes. This is largely a product of sprawl development far away from existing job centers. Integrated planning that considers transportation options and community design can result in jobs, transit and resources close to housing thereby reducing vehicle miles traveled and GHG emissions.

Some communities now call all relevant departments to go over plans with developers. That way, any inconsistent messages between various departments can be identified and resolved up front. This is highly recommended as a way to save time and money for both the city and the developer.

There are additional entities whose input, when appropriate, may lead to more consistent policies and better planning decisions. They include Water Districts, Air Pollution Control Districts, and Transit Agencies.

Resources

Model Policies for Greenhouse Gases in General Plans: a Resource for Local Government to Incorporate General Plan Policies to Reduce Greenhouse Gas Emissions. June 2009. Sacramento: California Air Pollution Control Officers Association. http://www.capcoa.org

Communities Tackle Global Warming: A Guide to SB 375, by Tom Adams, Amanda Eaken and Ann Notthoff. June 2009. NRDC Issue Paper. Washington: National Resources Defense Council. http://www.nrdc.org/globalwarming/sb375/files/sb375.pdf

The idea of Smart Growth has come a long way in Sacramento since 2001. In that year, the California Energy Commission sponsored an evaluation of local planning processes and published a catalog of development examples that followed the Smart Growth principles adopted by the National Governors' Conference. The catalog, entitled Shining PLACE3S, highlighted mostly state and national success stories; because Sacramento's planning efforts were still based on a suburban model established in the City's 13 year-old General Plan, local examples of smart growth development were limited to a handful of projects. Later in 2001, the city council added these 14 "Principles of Smart Growth" to Sacramento's 1988 General Plan:

- Mix land uses and support vibrant city centers.
- Take advantage of existing community assets emphasizing joint use of facilities.
- Create a range of housing opportunities and choices.
- Foster walkable, close-knit neighborhoods.
- Promote distinctive, attractive communities with a strong sense of place, including the rehabilitation and use of historic buildings.
- Preserve open space, farmland, natural beauty, and critical environmental areas.
- Concentrate new development and target infrastructure investments within the urban core of the region.
- Provide a variety of transportation choices.
- Make development decisions predictable, fair, and cost-effective.
- Encourage citizen and stakeholder participation in development decisions.
- Promote resource conservation and energy efficiency.
- Create a Smart Growth regional vision and plan.
- Support high quality education and quality schools.
- Support land use, transportation management, infrastructure, and environmental planning programs that reduce vehicle emissions and improve air quality.

With the adoption of these principles, decision-makers, developers and Sacramento residents began thinking about growth in terms of infill, density, transportation options and a better quality of life in sustainable, complete neighborhoods.

In 2002, the City started a Planning Academy to encourage citizens to take part in the planning process and become effective advocates for Sacramento's Smart Growth Initiatives. By 2009, 271 people have graduated from 10 Planning Academies, many of them becoming council members, city commissioners or effective neighborhood advocates.

Also in 2002, the Sacramento Area Council of Governments (SACOG) began a Regional Blueprint effort to identify smart growth land use patterns. Using the principles similar to those adopted a year before by the City of Sacramento, SACOG began to identify the benefits of shifting development away from the traditional single use, low density suburban model to one that encouraged more mixed use, compact and urban-style neighborhoods.

In February 2009, the Sacramento's Planning Department published its Sacramento Places document. Similar to the Shining PLACE3S catalog published eight years before, Sacramento Places details the benefits of smart growth. Unlike the earlier document, however, Sacramento Places is filled entirely with local examples of attractive, vibrant community development.

Sacramento Places can encourage economic development by showing prospective residents, businesses, and developers how the city is evolving in a positive and innovative way. It illustrates the smart growth principles that are included in Sacramento's new 2030 General Plan. Adopted in March 2009 after a four-year process that involved over 4,000 residents, the new General Plan details how determined Sacramentans will use the principles of smart growth to fight traffic congestion, deteriorating air quality, urban sprawl and the loss of open space, even as the area is projected to add an additional 200,000 people and 140,000 jobs by the year 2030.

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SECTION V

ENERGY AWARE STRATEGIES

ENERGY
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LAND USE AND TRANSPORTATION STRATEGIES

Key Facts

- Thirty-nine to forty-one percent of total energy consumption in California comes from the transportation sector. It is the largest single source of greenhouse gases in the State.[2] Passenger vehicles account for 74 percent of emissions from the transportation sector.[3]

- Integrated land use and transportation strategies can reduce energy and greenhouse gases (GHGs) from the transportation sector by reducing the number of automobile trips and the number of miles driven. Better land use planning that mixes commercial and residential uses puts people within walking or bicycling distance of their destinations, including transit, and can reduce driving by 20 to 40 percent.[4]

- The number of miles driven must be reduced for California to meet its GHG reduction goals.[5] AB 32, California's Global Warming Solutions Act of 2006, requires the state to reduce GHG emissions to 1990 levels by the year 2020, and sets a goal of 80 percent below 1990 levels by 2050.

- California's Attorney General has determined that greenhouse gases are a pollutant and must be addressed under the California Environmental Quality Act (CEQA). He has demonstrated his intention to take cities and counties to court if they fail to comply and has advised cities and counties to look at land use planning that reduces auto dependence as a mitigation measure.

- SB 375, signed by the Governor in 2008, establishes a framework for the statewide reduction of greenhouse gas emissions tied to transportation and land use. It directs the California Air Resources Board to set emission reduction targets for each of the state's 18 Federally designated metropolitan planning regions and requires the metropolitan planning organizations (MPOs) to create a "Sustainable Communities Strategy" to meet those targets.

The Transportation/Land Use Connection

Transportation and land use are inextricably linked. Compact land use patterns zoned for a variety of closely-spaced destinations encourage walking, bicycling, and use of public transit.

Dispersed, decentralized land use patterns are inconvenient for walking and bicycling and difficult to serve with public transit – automobiles are a more convenient alternative.

Addressing the Problem – Local Government's Role

There are four major ways local governments can influence the energy use, emissions, and greenhouse gases produced by automobiles:

1. Reduce the number of vehicle trips. Reducing vehicle trips has a significant impact on emissions of pollutants, since cold automobile engines release a large amount of pollutants when started.[6] Many of the strategies in the land use and transportation planning sections reduce the number of vehicle trips by making the alternatives to automobile transportation more attractive. Incentives and services such as a guaranteed-ride-home program or subsidized transit passes provide additional reasons to use alternative modes.

2. Reduce the number of miles driven. Reducing the number of miles driven by vehicles can also reduce pollutant emissions, fuel consumption, and greenhouse gases. Typically, vehicles emit about 20 pounds of carbon dioxide for every gallon of gasoline used.[7] Vehicle miles traveled (VMT) can be reduced either by eliminating the vehicle trip (see above) or shortening it. Vehicle trips can be shortened through more compact development patterns and well-connected street patterns.

3. Optimize driving. Fuel economy is typically greatest at moderate speeds, in the range of 30 to 60 mph, and is most optimal at steady speeds with few stops. Speeding, rapid acceleration, and hard braking can lower gas mileage by up to 33 percent and increase greenhouse gas emissions correspondingly.[8] Local governments can design and maintain traffic signals and other control devices to reduce unnecessary stops and delays while still maintaining safety. In addition, local government policies that reduce trips and VMT will help reduce congestion.

4. Drive efficient vehicles. Local governments have limited control over the types of vehicles driven by residents, but they can acquire fuel efficient vehicles for municipal fleets. See strategy C.5.3 Municipal Fleet Fuel Efficiency.

Reducing Miles Driven – California's Challenge

Reducing the number of vehicle miles driven in California will be a major challenge, especially given that vehicle miles are projected to increase due to population growth. The California Department of Transportation estimates that with 90 percent population growth between 1980 and 2020, the number of vehicles on the road will increase by 120 percent and vehicle miles traveled (VMT) will nearly double.

Indeed, VMT has been increasing so fast it threatens to undermine projected gains in vehicle efficiency that have been achieved through state and federal regulations. A 2007 study by the Urban Land Institute and Smart Growth America pointed out that if trends continue, VMT increases could prevent California and other states from meeting GHG reduction goals.

Investment in smarter, more compact communities is essential in order to offset the projected rise in vehicle miles traveled and to ensure California reaches its GHG reduction goals.

Implementing Strategies

The strategies in this section should be considered as a package. By implementing groups of related policies, greater reductions in vehicle and energy use are likely to occur. For example, providing shops and services within walking distance of homes will not be very effective without pedestrian facilities (e.g., sidewalks) linking homes to the shops. Similarly, reducing the amount of free parking will be most effective if more people live and work near transit and if incentives for using other modes of transportation are offered.

The following list includes the land use and transportation strategies included in the Guide.

Land Use and Transportation Strategies

Land Use Strategies

L.1.1 Smart Growth Development

- L.1.A Downtown Infill and Redevelopment
- L.1.B Industrial Redevelopment
- L.1.C Commercial Redevelopment
- L.1.D Transit Oriented & Transit Ready Development
- L.1.E Smart Greenfield Development

L.1.2 Land Use Diversity

L.1.3 Transit-Oriented Development

L.1.4 Design Sites for Pedestrian and Transit Access

L.1.5 Freight Movement Planning

L.2.1 Parking Pricing

L.2.2 Parking Supply Management

L.3.1 Complete Streets and Street Design

L.3.2 Street Trees

L.4.1 Bikeways

L.4.2 Bicycle Parking and Facilities

L.4.3 Pedestrian Facilities and Traffic Calming

Transportation Strategies

Background: California and Federal Clean Air Regulations

Background: Congestion Management Programs

T.1.1 Transit Fare Measures and Discounts

T.1.2 Increased Transit Service and Improved Travel Time

T.1.3 Park-and-Ride Lots

T.2.1 Transportation Demand Management (TDM) Programs

T.2.2 Transportation Management Associations

T.2.3 Guaranteed Ride Home Programs

T.2.4 Ridesharing

T.2.5 Carsharing

T.2.6 Telework

T.2.7 Alternative Work Schedules

T.3.1 Traffic Signal Timing

Endnotes

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SMART GROWTH DEVELOPMENT

Smart growth is a term use for compact, mixed-use developments where it is easy to get around on foot, bicycle, or by transit. Creating these types of environments can be an effective method of reducing greenhouse gas emissions and driving. Environments that mix commercial and residential land uses and put people within walking, bicycling or mass transit distance of their destinations can reduce driving by 20 to 40 percent.[1]

A smart growth environment can be created by applying the "5 D's" – density, diversity, design, destination, and distance to transit (see sidebar). However, a development may be subject to additional considerations and unique challenges depending on its context – whether the development is in an urban area, an industrial area, a commercial area, etc.

To illustrate how smart growth principles (the 5 D's) can be applied across a range of contexts, this section discusses five "smart development opportunities," or typical conditions in which new growth or change can occur across California's many jurisdictions. These include:

L.1.A: Downtown Infill & Redevelopment
L.1.B: Industrial Redevelopment
L.1.C: Commercial Redevelopment
L.1.D: Transit-Oriented & Transit-Ready Development
L.1.E: Smart Greenfield Development
Each smart development opportunity section highlights the unique challenges and opportunities associated with different urban contexts and provides case examples.

A conventional suburban site (left) contains widely spaced blocks, disconnected streets, and land uses (shown in color) separated by long distances. By contrast, a smart growth or traditional neighborhood development site (right) contains closely spaced, interconnected blocks and mixed land uses.

General Plan Language Ideas and Implementation Ideas

Smart growth development can be supported by application of the 5 D's discussed above. General plan language ideas and implementation strategies for each of the 5 D's are largely covered in other sections of the guidebook, as indicated below. Additionally, each of the development opportunity sites discussed in this section contains ideas for implementing the 5 D's in different development contexts.

Density

» General plan language ideas and Implementation

Creating High Performance Places with the 5 D's

High performing smart growth developments can be created through application of the "5 D's":

- Density **is the concentration of jobs or homes in a community or designated area. Higher densities are associated with shorter distances between destinations, leading to shorter trips and greater use of walking and bicycling.**
- Diversity **refers to the mix of land uses in a given community or area and the balance of jobs, housing, shopping, schools, and other daily needs and services. Greater land use diversity puts more destinations within a convenient walking or bicycling distance.**
- Design **refers to the interconnectedness of the street network in a community and can be measured in terms of intersection density, sidewalk completeness, block size, and other factors that combine to determine how walkable a community is and how far one destination is from another – whether travel is by car, foot, bike, or transit.**
- Destination **refers to a community's accessibility in the larger city or region and how connected it is to other centers of activity.**
- Distance to Transit **is about the level and type of transit service in a community and is measured as the distance from home or work to the nearest rail or bus stop.**

Cities can use knowledge of the Ds to assess development proposals and to look for opportunities to enhance walkability, livability, accessibility and health.

ideas for increasing density, especially in areas with transit access, can be found in L.1.3 Transit Oriented Development.

Diversity

» General plan language ideas and implementation ideas for increasing density can be found in L.1.2 Land Use Diversity.

Design

» General plan language ideas and Implementation ideas for improving street design connectivity and designing for pedestrian and bicycle access can be found in L.1.4 Design Sites for Pedestrian and Transit Access; L.3.1 Complete Streets and Street Design; L.3.2 Street Trees; L.4.1 Bikeways; L.4.2 Bicycle Parking and Facilities; and L.4.3 Pedestrian Facilities and Traffic Calming.

Distance to Transit

» General Plan language ideas and implementation ideas for reducing distances to transit and creating transit-oriented development can be found in L.1.3 Transit-Oriented Development and L.1.4, Design Sites for Pedestrian and Transit Access.

Destinations

» To increase access to regional destinations, new commercial and housing development should be sited in proximity to major urban centers or should be located adjacent to high-quality transit service providing convenient access to regional destinations.

Other Ideas

» Smart growth development functions best when it is consistent with regional transportation and growth plans. This can be assured by making the general plan consistent with the regional blueprint plan and the regional Sustainable Communities Strategy. See the background section on Integrating Local and Regional Planning for more detail.

Transportation Benefits

A recent literature summary concluded that environments that mix commercial and residential land uses and put people within walking or bicycling distance of their destinations can reduce driving by 20 to 40 percent compared with development on the outer suburban edge with isolated homes, workplaces, and other destinations.

A study in King County, Washington found that residents of the most walkable neighborhoods drive 26 percent fewer miles per day than those living in the most sprawling areas.[3]

A regional planning study in Sacramento estimated that growth scenarios focused on infill and higher densities could reduce average daily vehicle miles traveled (VMT) per household from about 51 to 35 in 2050, a reduction of about 30 percent, compared to trend growth conditions.[4]

Energy Savings and Environmental Benefits

One study focused on California estimated that savings from reduced vehicle miles traveled with compact development, smart transportation policies and compact building design can reduce statewide carbon dioxide (CO_2) emissions by 14.4 million metric tons to 17.9 million metric tons (MMT) by 2020.[5]

Another estimate concluded that applying smart growth and integrated planning best practices could reduce average vehicle miles traveled per capita by 10 percent and reduce annual U.S. greenhouse gas (GHG) emissions by 145 MMT of CO_2 by 2030 – the equivalent to the annual emissions of 30 million cars or 35 large coal plants.[6] Another national study, using more conservative assumptions, concluded that implementation of smart growth land use strategies nationwide could reduce cumulative CO_2 emissions by up to 1,445 million tons between 2010 and 2050.[7]

Economics

Smart growth and integrated planning can reduce the amount of money that local governments must spend on infrastructure costs by approximately 25 percent or more.[8] Savings result primarily from the fact that fewer linear miles of roadway, water and wastewater lines, and other utilities are needed to serve compact developments.

The Sacramento region's smart growth plan is projected to reduce CO_2 by 7.2 MMT through 2050. The Center for Clean Air Policy calculates a net economic benefit of $198 per ton of CO_2 saved from infrastructure and consumer fuel costs ($9 billion dollars in total).[9]

A McKinsey analysis for Georgia concludes that strategic investments in transit, demand management, and freight could yield net economic benefits of over $400 billion over 30 years.[10] Associated transportation GHG savings are estimated at 18 MMT CO_2.[11]

Smart growth can attract private investment, increasing municipal revenues through real estate taxes. In Atlanta, the Center for Clean Air Policy calculates that the Atlantic Station project will reduce CO_2 by a total of 0.63 MMT over 50 years at a net cost savings, because municipal tax revenues from the project will be greater than what is required to pay back the initial project loan.[12]

Meeting Housing Demand for the Families of the Future

Homes being built in California (and across the U.S.) have become increasingly out of touch with demand and the changing demographic profile of the population. Single-person households now outnumber married-couple households. People in their mid-twenties and the aging baby boomers represent the fastest growing portions of our population. With this changing population come changing real estate preferences. Studies by the Urban Land Institute and others show that these households prefer smaller-lot and multifamily housing types, and walkable communities with more travel options.[2]

Smart growth can reduce household energy and transportation costs, freeing up disposable income, especially for working families. Households living in compact environments consume 20 percent less residential energy than otherwise comparable households living in decentralized environments.[13]

Health Benefits

Residents from high walkability neighborhoods (defined by higher density, greater connectivity, and more land use mix) report twice as many walking trips per week than residents from low walkability neighborhoods (defined by low density, poor connectivity, and single land uses).[14]

Increased activity reduces the rate of obesity (and attendant health risks such as type 2 diabetes, heart disease, and hypertension). An average 150-pound person living in an activity-friendly environment could prevent weight gain of 0.85 to 1.75 pounds per year, which approximates the average adult weight gain in the U.S.[15] A study conducted in Atlanta, GA indicated that odds of obesity declined as mixed land use increased.[16] Since annual health costs for obesity-related problems total over $76 billion, increasing activity levels and reducing obesity can potentially save the U.S. billions of dollars annually through improved productivity, reduced workers compensation claims, and reduced obesity-related health care costs.[17]

Resources

Smart Growth Zoning Codes: A Resource Guide (Local Government Commission, 2003) assists local government planners, attorneys and elected officials to understand, prepare, and adopt codes and ordinances. Available on-line: http://www2.lgc.org/bookstore/list.cfm?categoryId=1.

Codifying New Urbanism: How To Reform Municipal Land Development Regulations by Paul Crawford (American Planning Association, 2004) assists planners, officials, and citizens seeking to employ the principles of New Urbanism to development in their community by examining various ways to modify their land development regulations.

Special Section:
Smart Growth Opportunities

All California cities and towns contain myriad locations where smart, energy-efficient, and environmentally sensitive growth can happen. The intent of the following sections is to call out the unique advantages and challenges presented by typical development conditions. Whether they are located in existing downtowns or suburban areas, near transit stations, or on previously undeveloped land, the five "Smart Development Opportunities" covered all play significant roles in supporting smart growth.

Each Smart Development Opportunity section starts with a summary of key opportunities, barriers, and implementation strategies. followed by case studies of exemplary projects or plans. The case studies highlight notable implementation actions and successes, and feature summaries of how each project or plan meets the "5D" criteria of high-performance places, which reduce vehicle miles traveled and promote transit and non-auto trips.

The Smart Development Opportunity sections include:

- **L.1. A Downtown Infill & Redevelopment**
- **L.1.B Industrial Redevelopment**
- **L.1.C Commercial Redevelopment**
- **L.1.D Transit-Oriented Development**
- **L.1.E Greenfield Development**

L.1.A DOWNTOWN INFILL & REDEVELOPMENT

Cities across California contain vacant or underutilized sites or districts that are strong candidates for redevelopment and reinvestment. A 2005 study estimated that California's urban areas contain nearly 500,000 potential infill parcels, comprising about 220,000 acres.[18]

Opportunities

Established urban areas present key opportunities for high-performance downtown infill and redevelopment:

- Downtown areas in California typically exhibit the characteristics of smart growth – they tend to be more dense, have greater transit access, and a greater diversity of land uses. Increasing the supply of housing and workplaces in these areas can allow more Californians to choose to live in places where they are not dependent on automobiles to get around.
- Downtown sites tend to be job centers. Developing within these areas can increase the opportunities for workers to live near their worksites, therefore reducing the miles they must travel.
- Downtown areas are already served by transportation, water, and utility infrastructure. Building in these areas can reduce the municipal costs associated with serving new development.

Urban transformation. Public investments in infrastructure and other improvements can set the stage for private investment and development over time.

Barriers

Potential barriers include conditions that may make downtown infill and redevelopment less financially attractive compared to greenfield development:

- Existing zoning regulations that do not permit mixed land uses or higher-intensity development.
- Potentially higher land costs as compared with those for greenfield land at the urban edge.
- Difficulties in parcel assembly, as sites may encompass the properties of many owners.
- Up-front costs for the remediation of brownfield or contaminated sites, which may be a deterrent to developers.
- Costs for infrastructure improvement or capacity upgrades necessary to serve the intensity of new uses.

Implementation Strategies

Whether supported through general or specific plan processes, or implemented at the individual site scale, redevelopment requires an integrated approach. See the General Plan Language and Implementation Ideas referenced at the start of this strategy section, and consider these that are key for downtown areas:

- Establishing a community redevelopment agency with a clearly defined role in implementing and supporting plans and projects within special districts.
- Using transfer of development rights (TDR) to promote development in strategic locations and at target densities.

Downtown Redevelopment: Pasadena

Transit-oriented downtown redevelopment
Pasadena, California

Downtown Pasadena's transformation from declining business district in the 1970s to the vibrant place it is today has made it a national model for downtown revitalization. With the 2004 Central District Specific Plan, the city created a land use concept that builds upon past successes, emphasizing the unique and complementary roles of seven "sub-districts" within the area.

Implementation

Pasadena's success is the product of decades of ongoing planning. The Central District Specific Plan regulates the distribution of residential development throughout the area, calling for more intense development around transit and encouraging diverse housing options in vertical mixed-use, loft, and live-work developments. Intensity ranges for mixed residential and commercial developments are assigned to foster a viable mix of activities in and among sub-districts and corridors, while design standards promote walkability and preserve the area's identity and historic character.

Targeted public investments have been critical to attracting and supporting downtown development. The city's construction of structured parking garages in Old Pasadena, the profits from which have funded the rehabilitation of historic buildings, has been credited with stimulating commercial development in that district. A business improvement district, funded by commercial tax assessments and managed by a non-profit business organization, provides maintenance, marketing, and security services.

Successes

Over 5,000 new units are planned for the 960-acre Central District, a target that has helped to steer more than 85 percent of new housing permits in the city to the downtown area. Most are within one-half mile of a light rail station, and 15 percent will be affordable. The framework of circulation, street design, and parking policies serves the objective that people be able to travel without cars – even with substantial residential growth, it is projected that traffic will be reduced.

Courtesy of PaulZykofsky/LGC

Regional rail transit investments and diverse housing options in Downtown Pasadena have been an important part of the city's strategy to stimulate downtown activity and further development.

For more information, contact the Planning Division of the City of Pasadena, or see http://www.ci.pasadena.ca.us/planning/deptorg/commplng/GenPlan/centdis.asp.

Why is Downtown Pasadena a high-performance place?

Density	48-87 residential units/acre; concentration of jobs
Diversity	Strong mixed-use emphasis along corridors
Design	Grid street network; medium block size
Destination	City center location; proximity to other centers
Distance to Transit	Most homes and businesses within ½ mile of regional light rail service

For information about how high-performance places help reduce VMT, see page L.1.1-1.

Downtown Redevelopment: Oakland Uptown

Downtown neighborhood redevelopment
Oakland, California

Downtown Oakland's Uptown District is well served by bus and rail transit and is within walking distance of Oakland's employment center. A major mixed-use redevelopment effort is helping to transform the Uptown from an area characterized parking lots and a high number of vacancies into a retail, housing, and entertainment center for the region. The mixed-use program includes over 2,000 residential units and 150,000 square feet of retail/commercial space in low- and mid-rise buildings oriented around a public plaza, two historic theaters, and a skating rink. Parking is located underground to preserve the urban feel and continuity of the streetscape.

Implementation

Public investment has been crucial in stimulating private investment in Uptown. The Oakland Community and Economic Development Agency provided extensive funding and support to make the Uptown plan a reality. The agency purchased the 38 properties comprising the project area, contributed to environmental clean-up costs, and paid for street and infrastructure improvements and the development of the public park. The redevelopment agency also provided the developer, Forest City, with a subsidy to help cover project costs; in exchange, the city will receive a return on project profits.

Successes

The Uptown plan has become a regional destination for arts, dining, entertainment, and nightlife. The plan pairs these attractions with an ample supply of new downtown rental housing with 5-minute access to BART, attracting residents who wish to commute by transit. Twenty percent of the units are affordable to households earning less than 50 percent of the Area Median Income.

For more information, contact the Redevelopment Department of the Oakland Community and Economic Development Agency, or see www.oaklandnet.com.

The Oakland Uptown plan, above, supplies new rental housing to a downtown district with regional transit access.

Why is Oakland Uptown a high-performance place?

Density	Urban density: 160 units per residential acre
Diversity	Mix of residential, commercial, and civic uses with entertainment focus
Design	Interconnected, walkable street network; historic development complemented by design guidelines for new development
Destination	High transit and roadway accessibility
Distance to Transit	Entire district lies within 1/4 mile of local bus and regional rail service

For information about how high-performance places help reduce VMT, see page L.1.1-1.

Downtown Redevelopment: Brea

Downtown redevelopment and revitalization through urban design and community planning
Brea, California

The City of Brea in Orange County, California embarked on a large-scale revitalization of its downtown, after the auto-oriented area experienced major decay in the 1980s. Including streets with bulb-outs, mid-street crosswalks, wide sidewalks, and buildings placed up to the lot line, Downtown Brea is now better oriented toward pedestrian mobility. Structured parking is located behind buildings that are oriented to the street. A diversity of uses includes restaurants, a theater, night clubs, office space, apartments, townhomes, and small-lot single family homes.

Implementation

The city hosted a design charrette early in the planning process to garner public input into downtown's future. With community approval, the city purchased numerous downtown properties in order to energize the revitalization project.

Along with various streetscape improvements, the city targeted two major revitalization strategies for downtown: (1) the replacement of blighted buildings and (2) the relocation of the main street away from the wide auto-oriented Brea Boulevard to the narrower, two-lane Birch Street. These efforts included moving existing businesses to new locations.

The city used four different architects to design new buildings on Birch Street, the city's new pedestrian promenade, resulting in a diverse, vibrant streetscape.

Successes

The downtown revitalization has attracted 250 new homes to the immediate area. The project has won numerous awards, including the California Redevelopment Association's Award of Excellence in Community Revitalization and the National Association of Housing and Redevelopment Officials' 2001 Agency Award for excellence in Program Innovation-Community Revitalization.

For more information, contact the City of Brea Development Services Department, (714) 990-7689.

Courtesy of Dan Burden/LGC

A revitalized mixed-use commercial core has attracted new homes and redefined Brea's once-blighted downtown.

Why is Downtown Brea a high-performance place?

Density	Small-lot single family homes at 10 units per acre, townhomes and apartments at higher densities; concentration of retail jobs and services
Diversity	Mix of commercial and residential development
Design	Pedestrian improvements to mitigate long block lengths
Destination	Proximity to other centers in Orange County
Distance to Transit	Within ¼ mile of regional and local bus service

For an overview of the components of high-performance places, see page L.1.1-1.

L.1.B INDUSTRIAL REDEVELOPMENT

Inactive or declining industrial sites and districts located at the edges of downtown areas or in other strategic locations within urban areas may be suitable for accommodating mixed-use development, or new forms of industrial development that are light enough to be compatible with adjacent residential uses.

Opportunities

Depending on their location, infrastructure, and existing connections, industrial areas can provide key opportunities for redevelopment:

» Many aging industrial areas are adjacent to existing transportation corridors or downtown areas. Increasing the supply of housing and workplaces in these areas can support shorter trip lengths and travel by alternative modes such as walking, biking, and transit.

» New industrial development can be directed to existing industrial areas in core locations that are home to now-outdated facilities, instead of to outlying areas. Municipalities can encourage local economic growth by promoting redevelopment that can accommodate innovative industries, such as green technology research & development and related light manufacturing operations.

Before and after. A former railyard in the Portland Pearl District, above, was redeveloped as the Hoyt Yards, a mixed-use development that now anchors the neighborhood.

» Older industrial districts often contain structures suitable for adaptive reuse. The historic character of a district can also represent a desirable amenity.

Barriers

Potential barriers relate to cost, land supply, and compatibility of land uses:

» Concerns associated with reducing industrial land supply by converting land to non-industrial uses, as the availability of land that can accommodate secondary-sector industries and employment is important to local and regional economic health.

» Conflicts between existing active industrial operations and adjacent new uses over noise, traffic, safety, and other potential concerns.

» Costs for site remediation, which relate to the extent of environmental contamination from former uses.

» Costs for public improvements, which can be relatively high in industrial areas not previously designed for pedestrian traffic or neighborhood needs.

Implementation Strategies

Because of land use compatibility and supply issues, industrial redevelopment, at any scale, should happen within the context of a broader strategy or plan. See the General Plan Language and Implementation Ideas referenced at the start of this strategy section, and consider these that are key for industrial areas:

» Performing industrial land surveys and subregional economic analysis to identify which areas should be preserved, or potentially redeveloped.

» Establishing tax increment financing (TIF), in particular to offset high site remediation and public improvement costs.

» Modification of development codes to allow or provide incentives for the rehabilitation, reuse, or strategic preservation of historic structures.

Industrial Redevelopment: Pearl District

Transformation of a downtown industrial area into a mixed-use, transit-oriented neighborhood
Portland, Oregon

Strategic redevelopment has transformed the Pearl District from a declining industrial area into a thriving urban neighborhood. Located close to downtown, served by the Portland Streetcar, and characterized by a mix of attractive new mid-rise buildings (with the most LEED certified buildings per square mile in the United States), converted warehouses, and vibrant civic spaces, the district has become a highly desirable place to live, work, and visit.

Implementation

The Portland Development Commission (PDC), the city's urban renewal agency, plays a critical role in the redevelopment of the Pearl District. The agency's unique governance structure allows it to effectively coordinate efforts and direct public investments to meet the city's goals for housing provision, neighborhood revitalization, and local economic development. Funded primarily by tax increment fund resources, the PDC in turn funds Pearl District planning, as well as the public outlays for major redevelopment projects within the district. The Hoyt Yards development, which put nine new buildings on a 34-acre former rail yard, was made possible by an agreement between the developer and the PDC, which financed the relocation of a roadway ramp that had divided the site in half. By supporting this and other key redevelopment projects, the PDC spurs ongoing private investment in the rapidly changing district.

Successes

Through strategic redevelopment, the city has vastly expanded its downtown housing supply, relieving growth pressure on the city and the Portland Metro region, as well as accomodating more households in compact, efficient multifamily units. The location efficiency and transit connectivity of the Pearl District brings the average annual household vehicle miles traveled (VMT) in the district to a very low 1,522 miles, with 41 percent of workers using transit. By contrast, households in Washougal, at the edge of the region, drive 20,255 annually, with only two percent of the population using transit.[19] The success of the Pearl District is evidenced not only by its VMT, high market demand, and low vacancy rates, but by the level of activity found along its streets and in its public spaces.

Demand for housing, office, and retail space in the Pearl District is high. Served by the Portland Streetcar (center), the district features new mixed-use development, converted industrial buildings (top), and vibrant public spaces. It is also home to a number of green building projects.

For more information, contact the Portland Development Commission, (503) 823-3200, or see www.pdc.us.

Why is the Pearl District a high-performance place?

Density	High residential and employment density
Diversity	Vertical mixed-use development surrounding prominent parks and civic spaces
Design	Small block size; high intersection density
Destination	Close proximity to downtown
Distance to Transit	All development in district falls within 1/4 mile of local streetcar service

For information about how high-performance places help reduce VMT, see page L.1.1-1.

Industrial Redevelopment: Atlantic Station

Mixed-use brownfield redevelopment
Atlanta, Georgia

Atlantic Station is a mixed-use redevelopment on 138 acres of the former Atlantic Steel Mill in downtown Atlanta. Comprising approximately 15 million square feet of planned development, Atlantic Station accommodates numerous urban apartments and townhomes, an outdoor mall, hotel space, and LEED-certified high-rise offices. The site also includes approximately 11 acres of parkland.

Implementation

The city rezoned the site from "Heavy Industrial" to "Central Area Commercial Residential Conditional," and enacted new design standards for the site. The new zoning ordinance stressed bike and pedestrian access.

The 138-acre site was deemed a "brownfield," requiring significant remediation. It was selected as a U.S. EPA "Project XL," helping its progression through the environmental review process. Remediation involved soil removal and implementation of a groundwater extraction system, costing approximately $10 million. The property is also subject to a conservation easement to ensure continued management of the site.

Successes

The development is anticipated to bring in $500 million in tax revenues over fifty years, exceeding the $195 million in upfront costs, including loan repayment.

Compared to other Atlanta developments, Atlantic Station is estimated to reduce carbon dioxide emissions by 0.63 million metric tons and vehicle miles traveled (VMT) by 30 percent over fifty years. Initial surveys found that Atlantic Station residents have on average 59 percent lower VMT than the typical Atlanta resident, and that employees at Atlantic Station have 30 percent lower VMT.[20] The project developers note that the compact nature of the site has prevented 1,000 acres in greenfield development in the Atlanta region.

For more information, see http://www.atlanticstation.com

Courtesy of EPA Smart Growth

Atlantic Station focuses a diverse array of housing options around a vibrant mixed-use core that incorporates restored historic buildings. The photo above shows redevelopment in progress.

Why is Atlantic Station a high-performance place?

Density	Moderate to high residential density and concentration of jobs
Diversity	Mix of residential, retail, and office uses, and parks
Design	New, walkable street grid established
Destination	Close proximity to Downtown Atlanta
Distance to Transit	Shuttle connects residents to regional transit service

For information about how high-performance places help reduce VMT, see page L.1.1-1.

L.1.C COMMERCIAL REDEVELOPMENT

Suburban environments typically contain an ample supply of large, single-use commercial areas such as strip malls, shopping centers, and office parks. These developments tend to be oriented towards the automobile, with large parking lots and widely spaced destinations that are difficult to access by foot, bicycle, or transit. If areas are underutilized, aging, or partially vacant, they may be good candidates for redevelopment into more efficient, compact, mixed-use developments.

Opportunities

The characteristics of existing single-use commercial sites present key opportunities for redevelopment:

» Sites are typically situated along key corridors and in proximity to existing residential areas, and may also be close to regional centers. Locating new residents and workers in these areas, as opposed to greenfield locations farther afield, can reduce vehicle miles traveled (VMT) and promote the use of transit and non-auto travel modes.

» A large supply of sizeable parcels may be available for redevelopment. A 2001 PriceWaterhouse Coopers study reported that nearly 20 percent of regional malls in the United States were "dead or dying";[21] since then the decline has accelerated. Large sites that do not involve parcel assembly are attractive to developers.

» Existing single-use commercial developments are already served by transportation, water, and utility infrastructure. Building in these areas can reduce the municipal costs associated with serving new development with utilities.

» Redevelopment enables the diversification of housing options in a suburban area. Compared to detached single-family homes, townhomes and multifamily units to own and rent can meet the needs of a broader range of household types and income levels.

» Municipalities can stimulate growth and diversification of the local tax base through new mixed-use projects.

Barriers

Potential barriers to commercial redevelopment include:

» Existing zoning regulations that do not permit mixed land uses or development at higher intensities.

» Strong community opposition to increased density or the potential effects of redevelopment projects, such as increased traffic.

» Concerns over the displacement of existing jobs and community-serving businesses, which should be addressed by redevelopment plans.

Implementation Strategies

Cities can drive the redevelopment of single-use commercial areas through direct public investment, public-private partnerships, and changes to land use regulations. See the General Plan Language and Implementation Ideas referenced at the start of this strategy section.

Courtesy of Steve Price for Dover Kohl & Partners and Glatting Jackson

Commercial Redevelopment: The Crossings

Redevelopment of a suburban mall

Mountain View, California

The Crossings is a compact, transit-oriented community located on an 18-acre site of a former and under-utilized auto-oriented retail mall. The community encompasses 397 housing units, including small-lot single family homes, townhouses, apartments, and rowhouses with ground floor retail. There is 5,000 sq. feet of retail within the project boundary. The design also includes pedestrian access to a pre-existng supermarket on an adjacent site.

Pocket parks, a connecting network of pedestrian paths, and public plazas define this walkable development. Residents enjoy a five minute walk to the adjacent train station, and a two minute walk to one of the neighborhood parks.

Implementation

The developer secured financing for this project by renegotiating the debt of the pre-existing shopping mall. Eighty-five percent of the units were offered at market rate, and the remainder were offered to households of low to moderate incomes.

Low parking requirements helped secure higher density. Garages placed to the rear of homes enhance the pedestrian experience. Streets were kept narrow for pedestrians; the narrowest are owned by the Neighborhood Association to meet fire department requirements.

The community was designed in coordination with the San Antonio Station Precise Plan, which aimed to center a distinct neighborhood near a new Caltrain commuter rail station.

Successes

Average annual household vehicle miles traveled (VMT) at the Crossings is estimated to be 11,000 miles, 41 percent lower than the 18,700 miles the same household would travel if located in a more conventional suburban neighborhood.[22]

The city obtained community consensus for this higher-density transit-oriented development after holding community design meetings to determine the area's future.

The Crossings received the 2002 American Planning Association (APA) Outstanding Planning Award for Implementation.

For more information, contact Joseph Scanga, Principal, Calthorpe Associates, (510) 548-6800, email: joey@calthorpe.com.

The Crossings is a compact, transit-oriented community located on the former site of an outdated suburban mall. The plan, above, shows the residential areas of varying densities. The shopping mall structure was recycled and used as foundation for new homes.

Why is The Crossings a high-performance place?

Density	Residential density of 22 units/acre
Diversity	Homes with accompanying retail and open space
Design	Internal pedestrian connections, narrow streets
Destination	High roadway and transit connectivity
Distance to Transit	Adjacent to a regional commuter rail station.

For information about how high-performance places help reduce VMT, see page L.1.1-1.

Commercial Redevelopment: Sonoma Mountain Village

Adaptive reuse in the green economy
Rohnert Park, California

Over the next decade, Rohnert Park, California, will become home to Sonoma Mountain Village, a 175-acre mixed-use community focused on the principles of sustainability, including zero carbon emissions and zero waste. The residents of the 1,980 homes (including accessory units) will be within a five-minute walk of 3,800 planned jobs; 825,000 square feet of commercial, office, and retail space; and shuttle service connecting to Sonoma State University and a planned commuter rail stop.

Implementation

A former site of Agilent Technologies, this business campus required rezoning from industrial to mixed use, accommodating some light industrial conditional use. Notably, the developer is engaging in adaptive reuse and retrofits of existing buildings.

The development is subject to a Sustainability Action Plan, encompassing ten principles of sustainable building, land use planning, operation, and management. The project's performance in light of these targets will undergo a bi-annual review through 2020 . The design aspects of the project are subject to a "SmartCode," or form-based code. The project design was completed in tandem with an application for the U.S. Green Building Council's pilot LEED-ND Platinum certification

The "SoMo Business Cluster," a non-profit business incubator created by the developer, supports emerging green industries within the development.

Successes

In 2008, Sonoma Mountain Village was awarded the the Governor's Environmental and Economic Leadership Award as a comprehensive land use planning model. It is also endorsed under the international "One Planet Communities" Program.

The SoMo Business Cluster has successfully incubated Codding Steel Frame Solutions, a zero waste, zero carbon, 100 percent solar industry that will produce recycled-steel panels for all new construction framing at Sonoma Mountain Village.

Courtesy of Codding Enterprises

The sustainable plan for Sonoma Mountain Village involves the adaptive reuse of existing industrial buildings. The building above comprises part of a 25-acre business center that already accommodates 600 employees in 21 businesses.

The development is projected to reduce greenhouse gas emissions by 82 percent and vehicle miles traveled by 54 percent by 2020.[23]

For more information, contact Kirstie Moore, Codding Enterprises, (707) 795-3550, email: kirstiem@codding.com.

What will make Sonoma Mountain Village a high-performance place?

Density	Residential density of 21 units/acre; high concentration of jobs
Diversity	Mix of residential, retail, employment, schools, and services
Design	Interconnected street grid
Destination	40 miles from San Francisco; proximity to other regional destinations
Distance to Transit	All residences within ¼ mile of a planned transit stop

For information about how high-performance places help reduce VMT, see page L.1.1-1.

L.1.D TRANSIT-ORIENTED DEVELOPMENT (TOD)

Transit-oriented development (TOD) is the term used to describe moderate- to high-density development that incorporates a mix of land uses, compact design, pedestrian- and bike- friendly environments, and public and civic spaces around the hub of a transit station, or along a transit corridor. "Transit-ready development" refers to development that has the same characteristics as TOD, but is instead oriented toward planned or potential corridors and service. While sites across all development conditions can be supported by transit, TOD specifically focuses new housing and jobs in the area one-quarter to one-half mile from a major transit station to encourage transit ridership and promote the creation of active neighborhoods.

In response to its many benefits and growing market demand, TOD has been on the rise across the country. Opportunities still abound, though, since many major transit stations in California are, as of yet, surrounded by existing parking lots and low-density, auto-oriented development.

Opportunities

The key opportunities of TOD are grounded in the benefits of good transit accessibility:

» The close integration of growth planning with transit investments create the conditions that allow residents and workers to drive less, lowering VMT at the local and regional levels.

» TOD helps fulfill needs for more compact, efficient housing options, while directly answering to growing market demand for homes and offices near transit.

» TOD helps bolster transit service. A Transportation Research Board study of several metropolitan regions showed that TOD built around a single station can increase ridership by as much as 20 to 40 percent.[24]

» TOD provides housing options that support lower household transportation costs, due to reduced auto use and ownership rates.

Barriers

A specific set of financial barriers can face TOD:

» Limited land availability, need for parcel assembly, and higher land costs around transit stations.

» Parking replacement requirements for station-area redevelopment, which may pose cost and design challenges. Complete replacement of existing parking capacity is a typical condition imposed by transit agencies, which seek to maintain station accessibility and ridership.

» High total development costs related to land and infrastructure costs, structured parking costs, and complex construction requirements.

Implementation Strategies

Local strategies for TOD should align with regional housing and transportation plans, where applicable. See the General Plan Language and Implementation Ideas referenced at the start of this strategy section, and consider the following, which are key for TOD. For a more comprehensive discussion of TOD, refer to strategy L.1.3 Transit-Oriented Development.

» Implementation of special zoning for "transit districts" or "transit villages" (typically defined as areas within ½ mile of stations) to ensure that development meets criteria for mixed uses, pedestrian orientation, minimum densities, and provision of affordable housing.

» Development of station area plans that include conceptual or specific land use plans, streetscape and design standards, maximum parking requirements, and guidelines that ensure multi-modal access and circulation.

» Support through redevelopment agency funding, which may be applicable to many, though not all, TOD areas.

» Formation of public-private partnerships to finance development.

» Use and leveraging of federal, state, and regional grants and funding for planning and capital costs.

Transit-Oriented Development: Metro Walk

Transit village supporting community revitalization
Richmond, California

Adjacent to the Richmond BART regional rail and Capitol Corridor Amtrak intermodal transit station lies Metro Walk, a 17-acre mixed use development that will include 231 townhomes and live-work units (most for sale and some for rent), 27,000 square feet of retail space, a cultural arts facility, and small neighborhood parks at full build-out. An estimated 110 jobs will be created. The community is designed not only to provide transit-supported housing, but to anchor efforts to revitalize an economically distressed area of the city.

Implementation

Metro Walk is the product of a collaborative planning effort that involved numerous agencies and organizations, including the Richmond Redevelopment Agency; BART and Amtrak; the Metropolitan Transportation Commission, the regional transportation planning agency; and Bridge Housing, a non-profit affordable housing developer. The project has been financed through federal (HUD economic development and TEA-21 transportation grants), state, regional, and local sources. Public funds were leveraged in partnership with the developer.

Metro Walk is on the leading edge of TOD growth in California. It is one of five completed and 18 approved or planned TOD projects on BART property, which in total represent $2.6 billion in investments. To promote development that supports transit and maximizes land value, BART is shifting away from its requirement that redevelopment replace existing parking at a 1:1 ratio, which has posed both cost and design impediments to TOD. Instead, BART is open to developing alternative access approaches that maintain ridership potential.

Successes

More than 90 percent of new homeowners at Metro Walk reported that transit access was a key factor in their decision to live there.[25] With the project, the city is targeting affordable home ownership with townhouses and live-work units, in part through an innovative mortgage assurance program that assisted incoming homeowners.

With its pleasant design and planned mix of retail and cultural facilities, Metro Walk will help to revitalize the neighborhood that surrounds the station area.

For more information, contact Michael Williams, Project Manager, Richmond Community Redevelopment Agency, (510) 307-8140, email: michael_williams@ci.richmond.ca.us.

Why is Metro Walk a high-performance place?

Density	14 housing units per residential acre on average
Diversity	Incorporates a mix of residential, commercial, and civic uses
Design	Interconnected, walkable street network; narrow streets
Destination	Proximity to Oakland, San Francisco, and other urbanized centers in the Bay Area
Distance to Transit	All homes within ¼ mile of an intermodal BART regional rail/Amtrak station

For information about how high-performance places help reduce VMT, *see page L.1.1-1.*

Transit-Oriented Development: El Monte Transit Village

Planned transit village at a regional bus hub
El Monte, California

El Monte, located less than 15 miles east of downtown Los Angeles, is home to the busiest metropolitan bus station west of Chicago. Over 20,000 riders pass through the El Monte Station daily, and expansion plans aim to make the station a regional intermodal hub. It is an ideal location for a transit village. As planned, the redevelopment of 60 acres surrounding the station would bring over 1,800 new housing units, 500,000 square feet of retail, dining, and entertainment space, a hotel, and a conference/exhibition center.

Implementation

The City of El Monte identified the project area for a potential mixed-use development as far back as the 1980s. The city collaborated with the El Monte Community Redevelopment Agency, Caltrans, and the Los Angeles County Metropolitan Transit Agency on feasibility studies of the area. After an economic downturn which delayed further progress, the opportunity to go forward presented itself when the Titan Group approached the city in 2004 about developing the site.

The developer identified two key opportunities to which the transit village could respond: first, local undersupply of retail for the middle-income bracket; and second, unmet market demand by young professionals for condominiums and townhomes.

A multifaceted community outreach process was undertaken to ensure that the development plan met the goals of local residents. The process resulted in the El Monte Transit Village Specific Plan, adopted by the city in September 2007.

Successes

According to a Southern California Association of Governments study, the project has the potential to reduce household VMT by over 33 percent[26]. These benefits will result from greater transit and commercial accessibility for local residents.

For more information, see www.elmontetransitvillage.com.

Courtesy of Strategic Economics

Courtesy of The Titan Group

A planned TOD next to one of the busiest bus hubs west of Chicago will provide housing and commercial options to El Monte residents.

What will make El Monte Village a high-performance place?

Density	Residential densities up to 60 units an acre; concentration of retail jobs
Diversity	Residential, retail, dining, entertainment, a hotel, and conference facilities
Design	Interconnected, walkable street network
Destination	13 miles from downtown Los Angeles; proximity to other regional centers
Distance to Transit	Centered around regional bus hub

For information about how high-performance places help reduce VMT, see page L.1.1-1.

Transit-Ready Development: Hercules Waterfront District

Transit-ready New Urbanist community
Hercules, California

The Hercules Waterfront District is a first in a series of redevelopment projects positioned to transform central Hercules from an auto-oriented to a pedestrian-oriented community. The District is a cluster of residential, commercial, and mixed-use development located on 167 acres of property formerly belonging to the Hercules (Dynamite) Powder Company. The Waterfront District includes a variety of compactly-spaced, single- and multi-family housing options connected by a thorough pedestrian network.

Implementation

The land uses, building types, and the architectural character of the area were developed in accordance to the Waterfront District Master Plan after an extensive community planning process. The project required modifications to the general plan and zoning ordinance. A Form-Based Code following the principles of New Urbanism defines many aspects of the design of the area, ensuring a walkable and accessible community.

Successes

The project is positioned next to a future regional transit hub in Hercules, which will include an Amtrak Capitol Corridor rail station and a ferry station. In addition, the project supports Hercules' vision for a nearby pedestrian-oriented New Town Center.

Hercules has some of the highest vehicle miles traveled in the San Francisco Bay Area, ranging from 40-70 miles per household per day.[27] A UC Berkeley study projects that the Hercules Waterfront District, combined with a functioning rail/ferry terminal, will reduce local VMT by approximately 40 percent. Along with other redevelopment projects, including the proposed New Town Center, the study estimates Hercules could reduce VMT by nearly 35 percent within its zone of influence (compared to traditional suburban growth patterns) and reduce CO_2 emissions by nearly 15,000 metric tons annually.[28]

For more information, contact Steve Lawton, Community Development Director, City of Hercules, or see www.herculeswaterfront.com

Courtesy of City of Hercules

Located on former dynamite factory land, the Hercules Waterfront District establishes a transit-ready community designed on the priniciples of New Urbanism. The District also creates walkable communities adjacent to the planned future Hercules New Town Center.

Why is the Hercules Waterfront District a high-performance place?

Density	Residential density ranges from 26 units per acre near future rail/ferry station to 5 du/acre in single-family homes
Diversity	Homes and residential/retail mixed-use adjacent to thriving business park
Design	Interconnected, walkable street network; narrow streets
Destination	Adjacent to future New Town Center; proximity to regional centers
Distance to Transit	Adjacent to a future rail/ferry station with bus connections

For information about how high-performance places help reduce VMT, see page L.1.1-1.

L.1.E SMART GREENFIELD DEVELOPMENT

"Greenfield" development refers to development on previously undeveloped land, which is typically found at the edge of metropolitan areas. While infill and redevelopment are the first-line options for sustainable development, greenfield development may also be necessary to accommodate California's growth.

Opportunities

The ability to comprehensively plan and design from the ground up underlies the key opportunities of smart greenfield development:

» New communities can be designed all at once to incorporate the 5 "D" principles of density, diversity, design, distance to transit, and destinations. This involves establishing a full range of codes to support compact, mixed-use development, including street connectivity and design standards that promote multiple modes of travel, form-based zoning codes, parking regulations, and urban design guidelines.

» New development plans can allow for the close coordination of land use plans with new utility, transit, and other public infrastructure planning. An integrated approach can lead to better community design and performance, as well as municipal cost savings.

Barriers

Potential barriers to smart greenfield growth include those which can typically face compact development, as well as those facing greenfield growth in general:

» Existing zoning regulations that do not permit mixed land uses or development at higher intensities.

» Market barriers, whether perceived or real, that inhibit compact development.

» Limited funding for advanced planning.

» Limited funding for new infrastructure.

» Limited new water supply.

» Fragmented planning processes that limit capacity for collaboration and comprehensive planning.

» Interest groups that may oppose planned development.

Implementation Strategies

High-performance, efficient greenfield development requires the application of a full range of comprehensive land use and transportation planning strategies. See the General Plan Language and Implementation Ideas referenced at the start of this strategy section, and consider these that are key for greenfield areas:

» Adoption of codes that redefine standards for new development going forward. This includes form-based zoning codes to encourage pedestrian-oriented mixed-use development; regulations that allow for vertical and horizontal mixed-use development; street standards that promote multiple modes of travel; and maximum, rather than minimum, parking standards to discourage driving.

» Designation of transit-oriented districts around existing or planned transit stations.

» Establishment of specific standards for transit-oriented development, aligning with regional TOD plans, if available.

» Use of technical modeling to show the impacts of alternative development scenarios relative to goals for environmental, economic, and community performance.

Greenfield Transit-Oriented Development (TOD): Orenco Station

Sustainable plan for smart greenfield growth
Hillsboro, Oregon

Orenco Station is a 190-acre community built adjacent to a MAX regional light rail station in Hillsboro, a suburb of Portland, Oregon. Designed according to the principles of New Urbanism, the community is home to 1,834 residential units, a mixed-use town center, and ample park space. The community fills market demand for housing close to Hillsboro's cluster of high-tech jobs with a range of housing types, including small-lot single-family homes, townhomes, live/work units, apartments, and accessory units, which are located throughout the town center and the surrounding residential neighborhoods.

Implementation

Orenco Station was made possible by a regionwide transit-oriented development strategy that involved significant collaboration among state, regional, and local agencies and governments. In line with the region's Metro 2040 growth management plan, the TOD program supports recommended densities around transit stations. The 18-mile, $963 million Westside MAX extension (largely funded by the Federal Transit Administration) was routed through undeveloped land to catalyze TOD. Orenco Station comprises part of the $825 million in new investment in residential and commercial development built around the line since its opening in 1998.

The New Urbanist design of Orenco Station required the creation of a new zoning ordinance that allowed for narrower streets, building setbacks, and side yard easements; accessory dwellings; live/work homes; and alley-loaded garages. Shops in the town center must line the street, with parking in the rear. Mixed uses are permitted and, in some places, required. These regulations make for a compact, pedestrian-scaled, walkable community.

Successes

A study found that 22 percent of residents commute by public transit, compared to the regional average of 5 percent.[29] Due to the community's design and transit accessibility, homes at Orenco Station have commanded a market premium of 20 to 30 percent above the area average.

Orenco Station's town center, top, and the MAX light rail station, at left, are within a ten-minute walk of the over 1,800 homes in the community.

For more information about Orenco Station and the Metro TOD Program, contact Metro at (503) 797-1757 or see www.oregonmetro.gov/tod.

Why is Orenco Station a high-performance place?

Density	18 housing units per residential acre on average
Diversity	Incorporates a mix of residential and commercial uses and parks
Design	Interconnected, walkable street network; narrow streets
Destination	15 miles from Portland; proximity to other city centers
Distance to Transit	Most homes within ½ mile of regional light rail station

For information about how high-performance places help reduce VMT, see page L.1.1-1.

Greenfield Planning: Fresno Southeast Growth Area

Sustainable plan for smart greenfield growth
Fresno, California

With the Specific Plan for the Southeast Growth Area (SEGA), the City of Fresno has elected to change the course set by its past decades of growth and effectively "hold the edge" of urban expansion onto the agricultural greenfield land surrounding the city. The SEGA plan lays out a framework of mixed-use centers and employment zones surrounded by residential areas of varying intensity, all connected via transit, walkable streets, and a network of multi-use trails and open spaces. Accommodating 45,000 homes and 37,000 jobs to 2050, the plan saves 9,300 acres compared to a decentralized, auto-oriented business-as-usual alternative. Plan adoption is pending the completion of an environmental impact review (as of September 2009).

Implementation

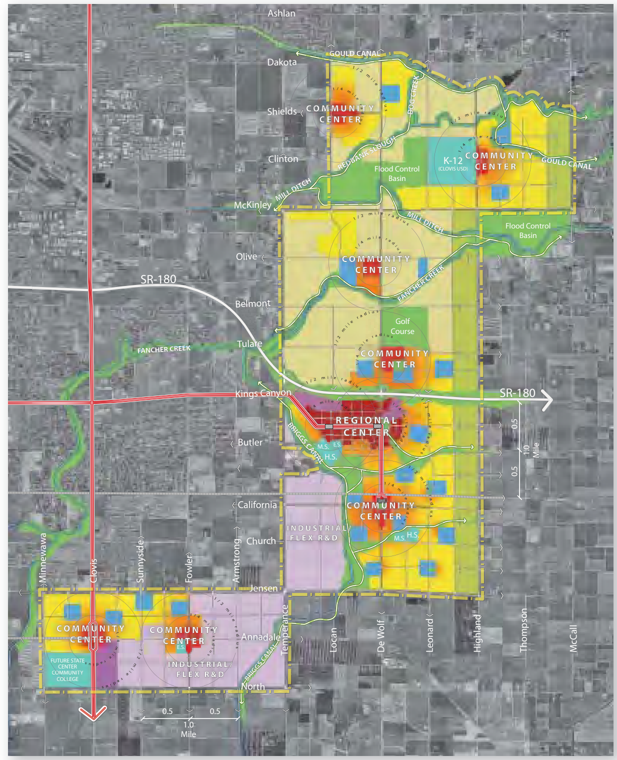
The SEGA plan sets aggressive goals for reducing VMT, energy, and water use; developing renewable energy systems and sustainable water management infrastructure; building sustainably; preserving agricultural land; and supporting urban agriculture. An integrated land use and transportation plan, which emphasizes multi-modal mobility and access to mixed-use centers, coordinates with a robust framework of policies to achieve the plan objectives.

The plan concept for the location and distribution of land uses and transportation infrastructure is regulated by the innovative SEGA Development Code, which represents a hybrid between use-based zoning and form-based codes. Street and district standards, new to Fresno and to be adapted for citywide use, regulate urban form to ensure the creation of well-designed communities.

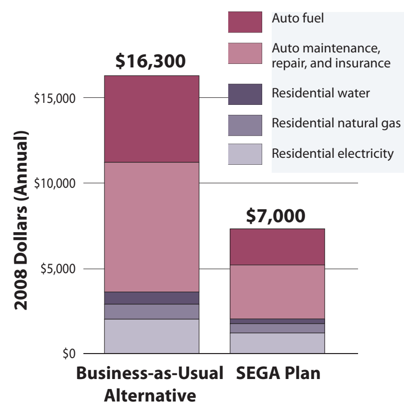
Successes

Detailed technical modeling of three alternative growth scenarios revealed the SEGA plan's full range of environmental, fiscal, and community benefits. Notably, annual household VMT is estimated to average 10,000 miles, or less than half that of the 26,000-mile average of the more dispersed business-as-usual scenario.

For more information, contact Keith Bergthold, Interim Director, Planning and Development Department, City of Fresno, (559) 621-8277, email: Keith.Bergthold@fresno.gov; or see www.fresno.gov.



Courtesy of Calthorpe Associates



Household costs in the SEGA plan, above, are much lower due to reduced needs for auto fuel, energy, and water. Reduced VMT decreases expenditures on gas and repairs, while smaller-lot single family homes and multifamily homes require less energy and water and cost less to heat and cool. These and other modeled metrics demonstrate the benefits of the SEGA plan. (Preliminary results pending EIR completion.)

What will make Fresno SEGA a high-performance place?

Density	19 units per residential acre on average; ranges to 100 units per acre at maximum
Diversity	Centers incorporate a mix of residential, commercial, and civic uses
Design	Highly interconnected, walkable street network
Destination	High roadway and planned transit connectivity
Distance to Transit	96 percent of homes within ½ mile of local or regional transit service

For information about how high-performance places help reduce VMT, see page L.1.1-1.

Greenfield Development: Prairie Crossing

Compact rural conservation community on greenfield
Grayslake, Illinois

Prairie Crossing is a residential community built upon the principles of land conservation. Over 60 percent of the 677-acre site is maintained as open space, consisting of native prairies, pastures, lakes, ponds and wetlands. The community's 359 homes and 36 condominiums have been built to strict energy standards. Two commuter rail lines are within walking distance of the community's Station Village.

Implementation

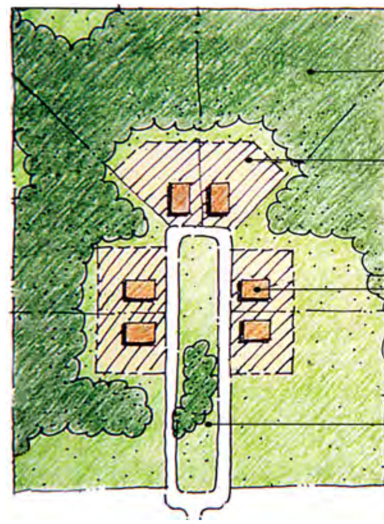
The developers and community interest groups at Prairie Crossing obtained federally funded conservation easements to protect open space as part of the development. They also utilized a portion of their conservation funds to establish the Liberty Prairie Conservancy, a community stewardship organization that manages the prairie reserve. Management is funded through a variety of sources. The Conservancy is now supported through membership dues, program grants, and operating support from the Liberty Prairie Foundation. The Foundation, a separate entity from the Conservancy, collects revenues from funds generated by a transfer fee every time a house at Prairie Crossing is sold. This arrangement is ingrained into the deed restrictions on the properties. The Foundation also collects tipping fees from an adjacent landfill.

Homes at Prairie Crossing were built under Building America, a U.S. Department of Energy research program designed to promote the development and implementation of advanced building energy technologies for new and existing homes.

Successes

Houses constructed at Prairie Crossing use approximately half as much energy as comparable housing units, at a marginal initial cost premium.[30] Thicker walls provide 60 percent more thermal resistance, while glazed windows and state-of-the-art mechanical systems further help yield an annual energy cost savings in excess of $400.

For more information, contact the Prairie Crossing Institute, (847) 549-5400, email: infocenter@prairiecrossing.com, or see www.prairiecrossing.com



A development pattern that clusters homes, as in the illustrative diagram above, is part of a strategy that helps Prairie Crossing preserve land.

Why is Prairie Crossing a high-performance place?

Density	Homes are clustered to commit contiguous open space to conservation easement
Diversity	Farmer's market, community space, shops, and offices near homes
Design	Streets designed for safe bike and pedestrian access
Destination	Proximity to Chicago and other major cities
Distance to Transit	All homes within ½ mile of two regional rail lines

For information about how high-performance places help reduce VMT, see page L.1.1-1.

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LAND USE DIVERSITY

Strategy L.1.1 discussed the five D's of smart growth and highlighted how land use diversity (i.e., mixed land uses) is a key component of high performance places. This section focuses specifically on strategies to increase diversity. Increasing diversity through mixing of land uses shortens the distance between origins and destinations, thereby encouraging less energy intensive transportation modes such as walking, biking, or public transit.

A quick assessment of land use diversity can be had by visiting www.walkscore.com. The site calculates walkability for any site based on the mix of destinations nearby.

Ground floor, retail, and upper-floor office space are combined at the Fruitvale Transit Village in Oakland, California. Plans are underway to add residential units.
Image credit: Flickr/Payton Chung.

General Plan Language Ideas

» The City/County shall adopt mixed-use zones that incorporate housing and employment in the following areas: [specify areas, such as downtown and adjacent to rail stations].

» The City/County shall encourage the integration of housing and commercial uses in the following areas: [specify areas and revise map to reflect the change, if necessary]. The general commercial and mixed use land use designations in these areas shall allow residential development of up to [number] dwelling units per acre or at floor area ratios of up to [number]. The City/County also shall offer incentives to integrate housing into these areas.

» New commercial developments of over [number] square feet shall include housing, or be located adjacent to existing or planned housing, when the land uses are compatible. New large employment sites shall include shops and services on site and/or within walking distance (one quarter to one half-mile or less) of existing shops and services. Sidewalks shall be provided, directly linking employment sites with shops and services.

» New residential subdivisions shall include or be located within walking distance of neighborhood shops and services. Higher-density use should be located closest to activity center (one half-mile or less, depending on terrain) with [fraction] of lower-density use within the half-mile range.

- New projects shall demonstrate how they will contribute to the formation of a complete and integrated community before approval.

Implementation Ideas

- **Revise the zoning code to permit land use mixing.** Allow residential uses in existing downtown areas and other areas zoned for compatible commercial uses, such as offices and retail. For example, housing could be allowed above ground-floor commercial space and live-work space could be allowed in commercial districts.

- **Adopt form-based zoning codes.** Form-based codes use spatial and physical urban design concepts to shape the form of the built environment, rather than regulating by types of uses. As such, they are particularly well-suited to encouraging mixed-use development. Requirements for frontages, planters, bringing buildings to the street, building exteriors, building location in relation to the lot, and streetscape standards are examples.

- **Prepare and adopt design guidelines defining the desired density and mix of uses.** If carefully drawn and faithfully enforced, design guidelines can help assure that new developments will reflect the characteristics considered to be most important to transit- and pedestrian-friendly neighborhoods.

- **Revise the zoning code to require development of compatible uses.** Require that shops and services be on the ground floor, with public access. Require a specified percentage of the square footage in new commercial buildings to be devoted to shops and services that will serve employees. This policy could apply to large developments over 100,000 square feet.

- **Use performance zoning or standards that encourage shops and services at employment centers.** For example, if a performance zoning system is adopted based on a point system, award additional points for having shops and services on site.

Form Based Codes

"Form based codes represent a method of regulating development to achieve a specific urban form. This is in contrast to conventional zoning's focus on the micromanagement and segregation of land uses, and the control of development intensity through abstract and uncoordinated parameters (e.g., Floor Area Ratios, dwellings per acre, setbacks, parking ratios, traffic level of service) to the neglect of an integrated built form.

Form-based codes address the relationship between building facades and the public realm, the form and mass of buildings in relation to one another, and the scale and types of streets and blocks."

Text excerpted from the website of the Form Based Codes Institute, http://www.formbasedcodes.org.

- **Provide incentives for mixed-use development.** Offer density or height bonuses and other incentives to projects that include a mixture of land uses. Reduce developer fees or grant property tax credits for mixed-use developments. Revenue losses may be offset by the reduced burden on infrastructure. If a point system of performance zoning is used in the city/county, award extra points for commercial developments with housing. Expedited processing, reduced fees, or reduced parking requirements may encourage development. When approving large-scale, mixed-use developments, require phasing of the project to assure that housing and commercial uses will be built simultaneously.

- **Establish "linkage" fees for building new housing.** Housing "linkage" fees on new commercial developments can be used to subsidize or build housing within the city limits. Linkage fees require developers of commercial space to pay into a housing trust fund to support infill residential development. See Programs in Operation below for more detail.

- **Establish new housing priority for nearby workers.** As a condition of development or in return for additional incentives, developers could offer housing first to workers employed at the development. If companies offer relocation allowances, larger allowances could be offered to employees living closer to the worksite.[1] This could be aligned with redevelopment authorities to require housing and commercial uses in redevelopment areas.

- **Prepare and adopt Specific Plans.** Prepare specific plans or provide guidance in community or general plans for neighborhoods where new growth, infill, or redevelopment will be allowed to occur. Consider prescribing a specific mix of shops and services to maximize benefits.

- **Revise the subdivision ordinance.** Encourage new subdivisions to include a mix of services within walking distance (one quarter to one half-mile or less) of most homes. A performance approach could be used, where points are awarded for each service located within walking distance of homes.

- **Adopt a Traditional Neighborhood Development (TND) Ordinance or Overlay District.** In most communities, existing zoning codes inadvertently prevent the development of walkable, mixed-use neighborhoods. The TND ordinance is designed to allow a builder to recreate a traditional, pre-World War II design. The communities that have adopted such an ordinance present it as a one page blueprint prescribing the neighborhood size; location of shops, workplaces, schools and residences; street size; building size and character; the provisions of squares and parks and the location of civic buildings.

Transportation Benefits

- Increased land use mix tends to reduce the distances that residents must travel for errands and allows more use of walking and cycling for such trips. It can reduce commute distances (some residents may obtain jobs in nearby businesses), and employees who work in a mixed-use commercial area are more likely to commute by alternative modes.[2] According to a wide range of studies, transit accounts for an average of 6.4 percent of total travel to and from mixed-use development work sites compared to only 2.9 percent for sites without mixed-use development.[3] A Toronto, Canada study found that about 55 percent of internal trips were made on foot (compared to 26 percent driving and 19 percent by transit), with preference being given to "easy and pleasant" (pedestrian environment, no traffic conflicts) walking experiences.[4]

Energy Savings and Environmental Benefits

- Successful mixed-use developments encourage new and existing communities to use walking, bicycling, and public transit rather than single-occupant vehicles. As a result, emissions of criteria air pollutants and greenhouse gases decline due to reductions in local vehicle miles traveled (VMT). Reducing VMT and associated fuel consumption directly reduces carbon dioxide (CO_2) emissions; for every one gallon of gasoline saved, approximately 20 fewer pounds of CO_2 are released into the atmosphere.[5]

- Atlantic Station in Midtown Atlanta is an example of a successful mixed-use development infill project using previously zoned industrial land. On average, Atlantic Station residents generate eight vehicle miles per day and employees to generate 11 vehicle miles per day. These estimates compare favorably with a regional average VMT of more than 32 miles per person per day, among the highest in the nation.[6] This translates to a 36 percent reduction in driving emissions and vehicle-related energy use and better air quality for the Atlanta region.

Economic Benefits

- Mixed-use developments are often more economically attractive to developers than single-use projects. Local tax revenues also may be higher because the mixture of uses can increase land values, income and capital appreciation over time.[7]

» Because the current demand for mixed-use developments exceeds supply, the price-per-square-foot values of houses in mixed-use neighborhoods show price premiums ranging from 40 to 100 percent over the value of houses in nearby single-use subdivisions.[8]

» Due to the different occupancy profiles of residents, shoppers and employers, mixed-use developments can take advantage of shared parking, allowing parking facilities to be used more efficiently.[9] Mixed-use developments, when combined with transportation demand measures, can reduce parking demands by as much as 25 to 50 percent because parking can be shared between uses with different periods of peak demand.[10] Development costs can therefore be reduced by up to $1000 for each unneeded parking space. This benefit will only accrue if the city or county allows for a reduction in the number of spaces.

» Additionally, mixing land uses can make transit service more efficient and economical by concentrating development and providing demand throughout the day, rather than just during peak commute hours. This is also a justification for transit-oriented development.[11]

Programs in Operation

Examples of mixed-use developments can be found in L.1.1 Smart Growth Development. Additional examples are provided below.

To convert an older industrial area into a mixed-use residential and commercial area adjacent to the downtown, the City of **San Jose** has developed the Jackson-Taylor Residential Strategy, which aims to increase the number of housing units by over 2,000 at densities up to 50 units per acre. In addition, the draft plan includes 560,000 sq. ft. of new office space, 100,000 sq. ft. of new retail space, and an additional 175,000 sq. ft. of industrial space. The Strategy calls for pedestrian-oriented design that supports public transportation. Contact: Laurel Prevetti, Assistant Director of the Planning Division, 408-535-7901.

In California, the cities of Palo Alto, Menlo Park, Berkeley, San Francisco, Santa Monica, San Diego, West Hollywood and Sacramento and Sacramento County, among others, have housing linkage fee programs that require developers of commercial space to pay into a housing trust fund. Several jurisdictions offer the option of constructing housing.[12]

The town of **Loomis** is using the specific plan as a tool for revitalizing their 490-acre town center while creating a compact, mixed-use, pedestrian-oriented community core. The plan, also called "The Village at Loomis," provides for new residences (up to 12 units per acre), businesses and shops while strengthening the existing shopping district and preserving the small town character of the existing residential neighborhoods. Paths and trails for equestrians, pedestrians, and bicycles provide direct access to all destinations. Detailed architectural/design guidelines have also been prepared to assure "human scale" development. Contact: Kathy Kerdus, Planning Director, (916) 652-1840, kkerdus@loomis.ca.gov.

Covering 4,700 acres only 15 minutes from downtown Denver, **Stapleton's** Sustainable Development Plan is a large infill mixed-use redevelopment of the Stapleton International Airport which closed in 1995. At build-out, the plan is for 30,000 residents and 35,000 workers in addition to parks, trails, and wildlife habitat. The mix of apartments, townhouses, live-work units and affordable housing choices are intended to be within a 10-minute walking distance from one of the town centers, each with a main street, shops and restaurants. Already winning several awards including the Environmental Achievement Award from the Environmental Protection Agency,[13] Stapleton has been touted as a successful example of mixed-use development. Contact: Tom Gleason, Vice President Public Relations, Stapleton Denver, 303.382.1800, tgleason@forestcity.net.

Resources

The Urban Land Institute (ULI) is a non-profit research and education and research organization that "provides leadership in the responsible use of land and in creating and sustaining thriving communities worldwide." ULI offers numerous books, project reference files, videos, conferences, and other resources. *The Mixed-use Development Handbook* (ULI, 2003) provides several examples of mixed-use developments and discusses issues of market feasibility, financing, design, planning, and marketing and management. Contact: customerservice@uli.org or call 1-800-321-5011. http://www.uli.org

American Planning Association's *21st Century Land Development Code* (APA, 2008) is a complete planning and law model code integrating traditional Euclidean zoning with green codes, new urbanism, and smart growth. Contact: American Planning Association, Planners Bookstore. PlanningBooks@planning.org or call (312) 431-9100. http://myapa.planning.org/APAStore

The National Cooperative Highway Research Program has launched an effort to enhance internal trip capture estimates pertaining to mixed use-developments. *NCHRP Report 8-51: Enhancing Internal Trip Capture Estimation for Mixed-Use Developments* is a two-phase project to produce a methodology for estimating internal trip capture estimates that include: 1) a classification system of mixed-use developments that identifies the site characteristics, features, and context that are likely to influence internally captured trips; and 2) a data-collection framework for quantifying the magnitude of internal travel to and around mixed-use developments to determine the appropriate reduction rates. http://www.trb.org/news/blurb_detail.asp?id=4257

Trip-Generation Rates for Urban Infill Land Uses in California. Phase 1: Data Collection and Pilot Application Final Report (Caltrans, 2008) is a report that describes results of the first phase of an extensive research effort Caltrans has undertaken to produce more accurate multimodal trip generation rates data for infill development in California. The goal was to show that trip generation rates produced by the Institute of Transportation Engineers (ITE) for proposed development projects located in existing urban infill areas potentially significantly over predicts vehicular traffic impacts and underestimates trips made by transit, walking, and bicycling. The first phase looked at 13 initial sites using a new methodology, and the second phase is underway to examine 10 urban infill land uses in California. Contact: Terry Parker, Senior Transportation Planner, Terry_Parker@dot.ca.gov or call (916) 654-5547.

America's Suburban Centers – The Land Use-Transportation Link (Unwin Hyman, 1989) by Robert Cervero analyzes transportation patterns for several large-scale suburban employment centers, demonstrating the difference in commute patterns when such centers include a mix of uses. Contact: American Planning Association, Planners Bookstore. PlanningBooks@planning.org or call (312) 431-9100. http://myapa.planning.org/APAStore

Municipal Research and Services Center of Washington has assembled a comprehensive webpage describing model mixed-use policies and codes in various U.S. cities, including specific information on parking reduction and work-live units. http://www.mrsc.org/Subjects/Transpo/MixedUse.aspx

The Local Government Commission's *Smart Growth Zoning Codes: A Resource Guide and CD* (LGC, 2003) offers research on more than 150 "smart growth" zoning codes form across the nation and will guide planners in designing a zoning code that encourages the construction of walkable, mixed-use neighborhoods. Contact: pubs@lgc.org or call (916) 448-1198. http://www2.lgc.org/bookstore

The Congress for New Urbanism, founded in 1993, is an urban design movement that set to reform many aspects of real estate development and urban planning from urban retrofits to suburban infill. New Urbanist neighborhoods are designed to contain a diverse range of housing and jobs, and to be walkable. For more information on New Urbanism, visit http://www.cnu.org

Related Strategies

L.1.1	Smart Growth Development
L.1.3	Transit-Oriented Development
L.1.4	Design Sites for Pedestrian and Transit Access
L.3.1	Complete Streets & Street Design
L.4.1	Bikeways
L.4.2	Bicycle Parking and Facilities
L.4.3	Pedestrian Facilities and Traffic Calming
T.2.1	Transportation Demand Management Programs

Endnotes

1. Several companies relocating to the Bishop Ranch office park outside of San Francisco offered relocation allowances proportional to distance, as cited in Cervero, Robert. 1989. *America's Suburban Centers: The Land Use-Transportation Link.* Boston: Routledge.
2. Kuzmyak, R. and Pratt, R. 2003. "Chapter 15: Land Use and Site Design." *Transit Cooperative Research Program (TCRP) Report 95: Traveler Response to Transport System Changes.* Washington: Transportation Research Board.
3. Ibid. p. 15-86.
4. Filion, P., McSpurren, K., and Huether, N. 2000. *"Synergy and Movement Within Suburban Mixed Use Centers: The Toronto Experience."* Journal of Urban Affairs, Urban Affairs Association Winter 2000, p.420, 428-434. http://www.blackwell-synergy.com/links/doi/10.1111/0735-2166.00064/abs.
5. Calculations based on Energy Information Agency. http://www.eia.doe.gov/oiaf/1605/coefficients.html.
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10. Example provided in Litman, Todd. 2004. *Parking Management: Strategies, Evaluation and Planning.* Victoria, BC: Victoria Transport Policy Institute. p.4. http://www.vtpi.org/park_man.pdf.
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12. Research conducted by Keyser Marston Associates. http://www.keysermarston.com.
13. Rehder, T. 2007. "Stapleton developers recognized by EPA." Washington: U.S. Environmental Protection Agency. http://yosemite.epa.gov/opa.

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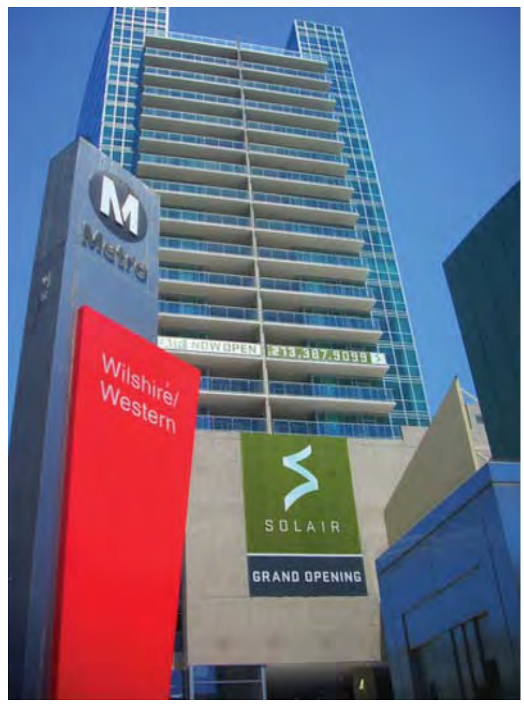
TRANSIT-ORIENTED DEVELOPMENT

Transit-oriented development (TOD) is the term used to describe moderate to high density development that incorporates a mix of land uses, compact design, pedestrian- and cycle- friendly environments, and public and civic spaces around the hub of a transit station or along a transit corridor. By placing more housing and employment near existing and planned rail transit stations and express bus stops, more people are likely to use transit and walk to the station, rather than drive.[1] The intended result of successful TOD implementation means a higher share of transit use for those living in and around the TOD, a dynamic destination for residents, shoppers and employees, and reduced energy footprint through compact development. When coupled with other transportation demand management strategies such as parking and management policies, this could also mean reduced vehicle miles traveled and lower vehicle ownership. In an ideal situation, TOD should lead to value recapture for the site, a financial return for the developer, and increased residential choice.[2]



This high rise condominium complex with retail on the ground floor was built directly adjacent to the Wilshire Boulevard/Western Avenue station in Los Angeles. The site was formerly a parking lot.
Image credit: Flickr/LA Wad.

General Plan Language Ideas

» Transit-oriented development should be encouraged at existing or proposed transit nodes, defined by the convergence of two or more modes of public transit such as heavy rail, bus, shuttle service, light rail or electric trolley, ferry, and inter-city or commuter rail. TODs should be pedestrian oriented, encourage night and day time use, provide the neighborhood with needed goods and services, contain a mix of land uses, and be designed to be compatible with the character of surrounding neighborhoods. They should promote neighborhood-serving commercial development within one quarter to one half mile of established transit routes and nodes, encourage transportation improvements that facilitate economic development, and link transportation facilities and infrastructure improvements to recreational uses, job centers, commercial nodes and social services.[3]

» The City/County encourages higher density housing near transit and shall revise the zoning code and offer incentives to locate more housing within easy walking distance of transit stops and stations. The zoning code shall be amended to include shops and services in and adjacent to transit centers and existing employment centers.

» For each area surrounding a transit station, the City/County shall adopt a specific plan or station area plan designed to provide adequate housing densities to support transit. The plan(s) also will include convenience shops and services, bike and pedestrian access, bike parking and other amenities to increase transit use.

» A majority (or __ percent) of all new employment will be concentrated within one half mile of existing and planned rail stations and transit centers. A specific plan will be developed to direct land use and urban design within one half mile of each rail station and transit center. The zoning code will be revised to reflect this policy. In addition, all new commercial buildings over 10,000 square feet shall be located within one-quarter mile of existing or planned bus or rail transit service.

» New auto-oriented land uses (e.g., auto dealers and repair facilities) and land uses with low employment densities (e.g., warehouses) shall not be located within one-quarter mile of a rail station or transit center.

Implementation Ideas

» **Prepare and adopt a station area plan.** Develop a station area plan with station access and circulation plans for motorized, non-motorized and transit access. The plan should clearly identify and propose strategies to overcome any barriers for pedestrian, bicycle and wheelchair access to the station. Implementation steps, including any necessary changes to local policies; an assessment of market demand for the proposed development; and potential phasing of development should also be included.

» **Prepare and adopt specific plans or area-specific general/community plan recommendations for neighborhoods that encourage transit-oriented development.** For areas with high employment concentrations and areas around transit stations, prepare a specific plan that includes zoning for shops and services. Consider prescribing a specific mix of shops and services to maximize benefits, such as postal facilities, dry cleaners, child care, health clubs, banks, automated teller machines, convenience stores and restaurants. Adopt a specific plan for the area around a rail station and transit center that includes high intensity land uses, improved pedestrian and bicycle access, neighborhood shopping and services, and incentives to use alternative modes and parking policies to discourage driving alone.

» **Revise the zoning code to include high-intensity land uses near transit.** Increase allowed residential densities within one quarter to one half-mile of transit stops. Housing density near rail stations should be at least 20-30 units per acre near rail stations and 7-15 units per acre in neighborhood served by buses, with varying density gradients from one eighth to one quarter-mile around the station.[4] Adopt minimum density requirements at these levels. In all cases, zoning also should allow or require complementary commercial uses adjacent to or on the ground floor of office buildings, including restaurants, dry cleaning, retail stores, banks, and postal facilities. These same principles should be used for land around bus transit centers or major bus corridors. Form-based codes, which regulate urban design parameters instead of uses, are a useful tool for encouraging mixed-use development. Prohibit concentrations of employment, such as office buildings over 10,000 square feet, in areas not served by existing or future bus or rail transit.

» **Offer density bonuses and development incentives.** Allow density bonuses for residential projects located near transit. Provide for a "transfer of development rights" (TDR) where development rights could be transferred from areas without transit access to areas within one quarter to one half-mile of major stops and stations. Additionally, redevelopment funds, tax breaks, reduced fees, expedited plan approval, infrastructure, and other incentives can be used to increase employment densities around transit stops and stations. A trip reduction ordinance or development agreement can require employers to provide additional incentives for transit.

» **Consider proximity to transit in performance-based zoning and development controls.** Many cities have adopted ordinances that limit development based upon trip generation or level-of-service standards. A few jurisdictions are adopting performance zoning, where land uses are determined based on the expected effects of certain land use decisions, rather than by predetermined types, heights, and densities. Close proximity to transit, particularly when coupled with complementary trip reduction policies, will reduce the number of automobile trips to the site. Proximity to transit should be ranked favorably in performance-based zoning and development standards.

» **Allow for reduced trip generation rates for TODs during environmental review.** Some cities are exploring alternatives to using level of service as an indicator of environmental impact during the environmental review process (EIR/EIS). A city could offer guidelines to allow developments to have reduced auto trip generation rates for TODs, translating into reduced mitigation costs and impact fees for the developer and creating more incentives to build TODs.

» **Pursue transportation joint development opportunities.** Work with the transit agency and developers to pursue joint development of housing and/or commercial uses on agency-owned land and adjacent to transit station. Housing could be built above parking garages or retail and service "liner" uses can be incorporated on the ground floor.

» **Coordinate with transit providers.** Changes in current routes, new bus routes and stops or new rail lines and stations may impact the type, location and amount of commercial zoning and vice versa. Invite representatives from transit providers to serve on committees or task forces developing specific plans and general plan revisions. Hold regular meetings to keep transit officials apprised of zoning and development activities. Consider forming a working group with neighboring jurisdictions to identify subregional transit needs.

» **Develop complementary parking policies.** Consider TOD-oriented parking demand and parking requirements for station area land uses, including consideration of pricing and provisions for shared, municipal, and/or on-street parking (see strategy L.2.2 Parking Supply Management). Reducing the amount of parking and charging for parking could encourage higher transit use by station area residents and workers, although it may discourage park-and-ride commuters from taking transit if supply is restricted. A detailed study of transit patrons should be conducted before a change in parking policy is implemented.

» **Provide excellent pedestrian and transit access.** The ability to walk or ride a bike to the transit stop should be emphasized. Make sure that pedestrians are not forced to use complicated routes to access the transit station and that an adequate amount of secure bike parking is provided. Pedestrian facilities (sidewalks, crossing signals, etc.) are necessary. See strategies L.1.4 Design Sites for Pedestrian and Transit Access, T.4.2 Bicycle Parking and Facilities, and T.4.3 Pedestrian Facilities and Traffic Calming for more details.

- **Prepare design guidelines defining the desired density and mix of uses.** If carefully drawn and faithfully enforced, design guidelines can help assure that new developments will reflect the characteristics considered to be most important to transit- and pedestrian-friendly neighborhoods. Transit village design policies and standards, including mixed use developments and pedestrian-scaled block size, can promote the livability and walkability of the station area.

- **Let government provide a model.** Locate all municipal facilities near transit.

Transportation Benefits

In a recent study of the effects of TOD on travel patterns in four metropolitan areas, transit-oriented development (TOD) housing produced considerably less traffic than what is generated by conventional development.[5] In fact, TOD households are twice as likely to not own a car and own roughly half as many cars as households not living in TODs. The research suggests that adjustments to traffic impacts may be appropriate because of the appreciably lower trip-generation rates of transit-oriented housing developments.[6]

Lower auto ownership and trip rates are partly due to the fact that households living in TODs tend to be smaller than average, and also partly due to self-selection (i.e., people who would prefer to reduce their auto use move to TODs). Nevertheless, there is compelling evidence that TODs provide an overall benefit to reducing vehicle travel.[7] Maintaining personal mobility while decreasing VMT means that that more trips are made locally by non-motorized modes, or through transit trips. On the average, local reductions in VMT of 20-30 percent can result from increased transit use, walking and bicycling as modes of transportation.[8] A literature review of a range of TOD studies has shown that for peak periods (that often govern the design of roads and highways), transit-oriented apartments average around one half the norm of vehicle trips per dwelling unit. The rates varied, however, from 70-90 percent lower for projects near downtown to 15-25 percent lower for complexes in low-density suburbs.[9]

A comprehensive study on the travel characteristics of TOD residents and workers is the 2003 study, Travel Characteristics of Transit-Oriented Development in California found a clear link between TOD and transit trips.[10] Analyses of the travel characteristics of California TODs conducted by Lund et al. indicate a 5 times greater rate of transit use for residents of TODs than those of comparable or adjacent locations. Similarly, transit use for office workers was 3.5 times greater for TODs.

Energy Savings and Environmental Benefits

By shifting trips from auto to transit or walking and therefore reducing vehicle miles traveled, TOD can reduce regional air pollution and energy consumption rates. Additionally, because TOD consumes less land than low-density, auto-oriented growth, it reduces the need to convert farmland and open spaces to development. Thirdly, the increased walk and bike trips from well-designed TODs with pedestrian access and pleasant walking spaces can result in a host of public health benefits.

The comprehensive SMARTRAQ study conducted in Atlanta showed that neighborhood walkability, which is often associated with TOD, is linked to fewer per capita air pollutants. The SMARTRAQ air quality analysis found that each step up a five-part walkability scale results in a six percent reduction in oxides of nitrogen and a 3.7 percent reduction in volatile organic compounds, which interact to form ozone. Additionally travel patterns of residents in the region's least walkable neighborhoods generated about 20 percent higher carbon dioxide (CO_2) emissions than travel by those who live in the most walkable neighborhoods – about 2,000 extra grams of CO_2 per person each weekday.[11] Although this example represents a regional reduction in air pollutants due to reduced vehicle miles traveled, the local criteria pollutants still tend to be more concentrated around transit station areas, where there is more overall transportation activity and traffic around the transit hub.

Economics

Higher density housing, retail, and employment centered around transit usually produces more revenue to both the developer and the local government than lower density development. The increased tax revenues can offset local government costs associated with the new population. With increased congestion, access to transit is likely to become a selling point for commercial space. Therefore, developments with good transit access may experience higher occupancy rates and higher lease values, improving local tax revenues. In a study of Santa Clara County property values in 1998 and 1999, Cervero and Duncan found that multifamily residential projects within one quarter-mile of light-rail stops commanded a premium of around $9 per square foot ($96 per square meter), meaning that prices were 45 percent higher than those for comparable properties farther from the transit stops.[12] The most consistent finding from California is that for-sale residential properties near suburban commuter-rail stops enjoy premiums; in the case of San Diego, for example, such properties enjoy a 17 percent advantage.[13]

The Orange Line that runs through Arlington, Virginia is recognized as one of the best U.S. success stories of development around transit. The Rosslyn, Courthouse, Clarendon, Virginia Square, and Ballston Metrorail stations are all hubs of activity, with pedestrian-oriented, high-density residential, commercial, and office development nearby. In 1970, for example, the corridor had 5.6 million square feet (520,800 square meters) of office space and 7,000 residential units. By 2002, the total had reached 21 million square feet (1,953,000 square meters) of office space and almost 25,000 residential units. Development in the two Metrorail corridors in Arlington County (the Orange Line and the Blue Line) uses six percent of the land in the county but produces almost one half of the county's tax revenue.[14]

The economics of congestion has become a major challenge in today's ever sprawling development patterns. In order to capture the value of property around transit station, locating employment around major transit hubs can significantly improve a company's productivity. BellSouth Corporation in Atlanta considered the expensive costs of its employees stuck in traffic when it consolidated all its suburban offices into three central locations accessible from MARTA (Metropolitan Atlanta Rapid Transit Authority), the city's rail system.[15]

Programs in Operation

The Metropolitan Transportation Commission (MTC) in the Bay Area has adopted a Transit-Oriented Development (TOD) policy that is being applied to transit extension projects in the Bay Area.[16] The $11.8 billion Regional Transit Expansion Program that MTC adopted as Resolution 3434 in 2001 was accompanied by a strong policy directive to condition the allocation of regional discretionary funds for transit expansion projects on supportive local land use plans and policies. http://www.mtc.ca.gov

The MacArthur BART Transit Village in **Oakland** is an example of coordinating TOD with other important redevelopment goals, such as affordable housing. The project expects to make 20 percent of the housing – 400-600 units – affordable to residents earning 50-80 percent of the area median income. These units likely will be built at densities of 100-125 units per acre on four stories of wood frame above parking and retail space. The other 80 percent of the residential units will be a combination of for-sale condominiums and market-rate apartments.[17] Contact: Kathy Kleinbaum, kkleinbaum@oaklandnet.com, (510) 637-0247.

The city of **Mountain View**'s commuter rail station is the focal point of "the Crossings," an 18-acre transit oriented development designed by Peter Calthorpe and developed in partnership with Caltrain. The site, formerly a shopping plaza, was transformed into a mixed use community that included 500 residential units, as well as single family, condominium and rental units in close proximity to the new Caltrain station. http://www.sonomatlc.org/LandUse/TOD/TODmodels/TOD-MountainView-San%20Antonio.htm

In 1998, the **Santa Clara Valley Transportation Authority** (VTA) created an in-house joint development program principally to tap the development potential of underutilized park-and-ride lots. VTA worked with the city of **San Jose** to develop a concept plan for the 1,100-space parking lot at the original Ohlone Chynoweth light-rail station. Another TOD implementation plan, the Santa Clara Station Area Plan can be found here: http://www.santaclarasap.com. Contact: VTA Planning Department at (408) 321-5744 or http://www.vta.org/projects/tod.html.

The **Portland, Oregon** region has the most aggressive TOD program in the United States.[18] The city has instituted an overlay zone called the Light Rail Transit Zone which increases permitted densities, restricts auto-oriented uses, and encourages pedestrian-oriented development in LRT station areas. To help simulate the construction of transit villages, Portland's metropolitan planning organization, Metro, operates the innovative TOD Implementation Program using Federal transportation funds. Contact: Megan Gibb, megan.gibb@oregonmetro.gov, 503-797-1753.

Interest in TOD has been propelled by ongoing rapid population growth, worsening congestion, air pollution, and an affordable-housing crunch in places like **Los Angeles**. Although LA's Orange Line is still too new for measurable TOD impacts,[19] other rapid bus corridors nationwide have developed plans for intensifying development around busway. The Parkville Station of the New Britain-Hartford Busway Project is an example of bus corridor TOD. The Capitol Region Council of Governments offers this project as a resource to the cities of New Britain and Hartford, the towns of Newington and West Hartford, and to public agencies with interests related to the New Britain/Hartford busway. Contact Mary Ellen Kowalewski, mkowalewski@crcog.org, 860-522-2217.

Resources

Caltrans has consolidated a database of 21 TOD sites in California with examples of website for transit-oriented development at http://transitorienteddevelopment.dot.ca.gov. Caltrans also has a variety of other initiatives that support TOD development. http://www.dot.ca.gov/hq/MassTrans/tod.html.

The TOD MarketPlace is an annual workshop organized by the Urban Land Institute, MTC, ABAG, Reconnecting America, and the Non-Profit Housing Association of Northern California, connecting city planners with developers who can help them realize their vision. The workshop-style event gives city planners the opportunity to get immediate, dynamic feedback on the feasibility and potential of making their plan a reality. http://www.bayareavision.org/marketplace.

In *TCRP Report 128: Effects of TOD on Housing, Parking, and Travel* (TRB, 2008), G. Arrington and R. Cervero explore the demographics of transit-oriented development (TOD) residents and employers, and their motives for locating in TODs. The report also examines the travel characteristics of residents before and after moving to a TOD and ways to increase transit ridership among these residents. In addition, the report reviews the potential effect of land-use and design features on travel patterns, transit ridership, and the decision to locate in a TOD. http://www.trb.org/news/blurb_detail.asp?id=9549.

A wealth of information for best practices and updated research about TOD. Reconnecting America/Center for Transit-Oriented Development has a series of publication and news stories focused on transportation and land use issues. http://www.reconnectingamerica.org.

A very comprehensive evaluation of TOD in the United States, Robert Cervero has authored *TCRP Report 102: Transit-Oriented Development in the United States-Experiences, Challenges, and Prospects* (TRB, Washington DC: 2004), examining the state of the practice and the benefits of transit-oriented development and joint development throughout the United States. http://www.trb.org/news/blurb_detail.asp?id=4060.

Exploring the "first generation of TOD projects," H. Dittmar and G. Ohland, G have published *The New Transit Town: Best-Practices in Transit Oriented Development* (Island Press, Washington, D.C.: 2004). This book brings together leading experts in planning, transportation and sustainable design to provide a taxonomy of TOD projects appropriate for different contexts and scales and performance measures that can be used to evaluate outcomes. A wider variety of case studies also help to give context.

For a real estate development audience, the Urban Land Institute has published *Ten Principles for Successful Development Around Transit* (Washington, D.C.: 2003). In an easy-to-read format, these principles can serve as reminders for communities, designers, and developers to review why pedestrian-scale communities suitable for public transportation are positive investments.

The Tri-County Metropolitan Transportation District of Oregon has assembled a Community Sourcebook which outlines TOD plans and policies in detail, and includes a walking tour of TODs. http://www.trimet.org/pdfs/publications.

Related Strategies

- L.1.1 Smart Growth Development
- L.1.2 Land Use Diversity
- L.1.3 Design Sites for Pedestrians and Transit Access
- L.1.4 Diverse and Compact Housing
- L.2.1 Transportation Demand Management Programs
- L.4.3 Pedestrian Facilities and Traffic Calming

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DESIGN SITES FOR PEDESTRIANS AND TRANSIT ACCESS

Strategy L.1.1 discussed the five D's of smart growth and highlighted how design features can contribute to higher rates of walking, bicycling, and transit use. This section focuses specifically on improving building site design to ensure convenient pedestrian and transit access. Street design is covered in strategy L.3.1 Complete Streets and Street Design.

To encourage pedestrian access, buildings should be adjacent to the street with minimal setbacks (no more than 10-15 feet for commercial and mixed-use or 20-25 feet for residential), rather than behind large parking lots. Primary entrances should open to the street and be located as close as possible to transit stops. Parking should be placed behind or to the side of the building to avoid impeding pedestrian access, and driveway widths should be minimized and sited so as to conflict as little as possible with pedestrian traffic. Ground floor uses facing the street should be "active" uses as much as possible (such as retail or community uses) and should be mostly transparent (e.g., windows, display cases) rather than blank walls facing the street.

Pedestrians and those accessing transit also benefit from good infrastructure (e.g., sidewalks and walkways), and a pleasant and safe walking environment. Strategy L.4.3 Pedestrian Facilities provides more detail.

This building in Pasadena is designed to afford easy pedestrian access from the transit station.
Image credit: www.pedbikeimages.org/Barbara Gossett.

General Plan Language Ideas

» The City/County Shall use local and collector streets to form a network of connections to disperse traffic and give people a choice of routes to neighborhood destinations such as schools, parks, and village centers.

- Direct and multiple street sidewalk connections shall be provided within development projects, to neighboring projects, and to the community at large.

- All new development should include continuous sidewalks along the property frontage.

- Pedestrian access should be provided to, from, and through the site, via streets or mid-block/off-street connections, at intervals of no greater than 400 to 600 feet.

» The City/County shall create street frontages with architectural and landscape interest to provide visual appeal to the streetscape and enhance the pedestrian experience.

- Design guidelines shall be adopted that specify maximum building setbacks, requirements for the design and placement of parking, requirements for building entrance placement, landscaping features, and ground-floor design practices to ensure that buildings are oriented to the street and that sites provide safe, comfortable, and convenient pedestrian circulation.

- A design review process shall be implemented to ensure that policies and guidelines are followed in new development.

» Access to and from transit stops and stations should be convenient and safe. The City/County shall prepare and adopt (with input from local transit agencies) development standards and design guidelines that integrate transit access into the development process. The standards and guidelines shall minimize the distance between building entrances and transit stops and provide direct sidewalks between stops and building entrances.

» New development located within one quarter-mile of existing or planned transit routes shall include transit-supportive densities and design. Where provided, follow the transit access standards and design guidelines adopted by the City/County.

» The City/County shall request input on proposed developments from affected transit providers.

Implementation Ideas

» **Establish a "Pedestrian Master Plan" that can guide pedestrian policies, projects, and priorities for the city.** The plan can be both an overall vision, as well as a strategic framework for improving the pedestrian realm, providing a guideline for public spaces, including streets and off-street paths, that offers a level of convenience, safety, and attractiveness to the pedestrian that will encourage and reward the choice to walk.

» **Improve existing standards and adopt new design guidelines.** Work with the transit agency to review current zoning and design standards, including those for parking, landscaping, and setbacks, to eliminate requirements that unintentionally make transit inconvenient. Adopt standards and design guidelines that will improve transit access.

» **Provide pedestrian-oriented design guidelines and encourage transit agency participation.** The first step is to establish design guidelines that support pedestrian- and transit-oriented elements. To better coordinate transportation and land use, the local jurisdiction should establish a process for the transit agency to review and comment on new development proposals for appropriate transit access and ask the transit agency to determine what is possible given staff and funding sources.

» **Involve developers in pedestrian and transit planning.** Provide a transit and pedestrian checklist for potential developers. Ensure that developers provide sidewalks and walkways to all building entryways and surrounding destinations. Require developers to install or pay for bus shelters at stops identified by the transit agency. In addition, work with the public works and transit agencies to develop maintenance agreements with building owners.

» **Consider design principles addressed in LEED-ND.** The U.S. Green Building Council Neighborhood Development Rating System[1] provides third-party verification that a development's location and design meet accepted high levels of sustainable development. LEED-ND guidelines can provide an overview of design characteristics that promote locations that are closer to existing town and city centers, have access to good transit, and are infill sites or previously developed sites adjacent to existing development.

Transportation Benefits

A more multimodal site design can reduce automobile trips, especially when implemented with other complementary measures such as improved transit services, better walking, and cycling conditions, and overall network connectivity.[2] When taken as an isolated variable, site design has been shown to produce a two percent travel reduction in sites like the Atlantic Steel development by Jacoby in Atlanta, Georgia.[3] Another study claims that grid-like street patterns and pedestrian-friendly designs have been associated with transit-usage levels that are as much as 20 percent higher than usage levels at typical suburban subdivision designs.[4]

Even though access to transit is often a key component in encouraging non-motorized trips, the compact, walkable and mixed-use designs of traditional neighborhood developments encourage pedestrian and bicycle travel, whether transit is present or not.[5]

Energy, Environmental, and Health Benefits

Energy savings and environmental benefits of pedestrian and transit-friendly urban design are indirect, linked closely to the transportation benefits. One study estimated that design in the form of transit-oriented development can help households reduce rates of greenhouse gas emissions by 2.5 to 3.7 tons per year as a result of fewer vehicle-trips and reduced vehicle miles traveled (VMT) per capita.[6] The study also states that "because of its location, design, and density, the Uptown District transit-oriented development (TOD) in San Diego was estimated to have 20 percent less emissions per household compared with households in nearby developments."

With regards to public health, researchers are beginning to understand the link between the built environment and the risk of obesity. Studies have shown that residents of walkable communities drive fewer miles and take more trips by foot and bicycle. Good transit access through direct and safe routes contributes to this walkability. A recent literature review found that 17 of 20 studies, all dating from 2002 or later, have established statistically significant relationships between some aspect of the built environment and the risk of obesity.[7]

Economic Benefits

One study found evidence that homebuyers are willing to pay $20,000 more for a house in a pedestrian-oriented neighborhood than for a similar home nearby.[8] Additional economic benefits may accrue through planning good access to transit. Transit can heighten nearby land values in a well-connected, highly accessible space for residential and commercial tenants. Without convenient rail or bus access, some municipalities are seeing their businesses and taxpayers leaving in favor of more transit-oriented alternatives.[9]

Efficient urban design with good access to transit has produced economic benefits for many cities. With careful site planning around transit stations, the City of Evanston, Illinois raised its total equalized assessed value by 191 percent between 1985 and 2004.[10] On the Hudson-Bergen Light Rail Line in New Jersey, the number of properties within transit zones doubled in one year with property values skyrocketing.[11]

Incorporating transit improvements in the initial stages of development leads to cost savings, including savings in personal travel time, transit operating costs, and enforcement costs (e.g., reduced need to clear parked cars from transit stops). Design for pedestrian and transit access may also lead to cost savings if municipalities reduce parking requirements to reflect the higher expected non-automobile mode share.

Programs in Operation

The City of **Mountain View** has developed a series of standards specifically for rowhouse design that incorporate attractive architectural and site planning elements with pedestrian access elements.

The regulations and guidelines establish how streets, pathways, and open spaces work together to organize development and provide guidance for character-defining architectural and site planning elements. The zone is intended to encourage high-density residential development in standard residential zones, where previously such development was allowed only in certain Precise Plan areas. Contact: Aarti Shrivastava, Community Development Department, City of Mountain View, 650-903-6452.

Downtown **Lodi** launched a $4.5 million public-private pedestrian-oriented project which retrofit five main street blocks, widened sidewalks, created curb bulb-outs at intersections and laid colored pavement on sidewalks and streets. The pedestrian improvements, in addition to complementary economic incentives, dropped vacancy rates from 18 percent to 6 percent, and increased downtown sales tax revenues by 30 percent. Contact: Tony Goehring, Lodi Economic Development Director, tgoehring@lodi.gov, (209) 333-6700.

Fresno's Fulton Mall is a six block long outdoor pedestrian mall, and is the centerpiece of Fresno's Central Business District. From the earliest days of Fresno, this corridor, once "Fulton Street," has been the heart of the city's downtown. The mall was built in 1964 as part of a major urban renewal project, was designed by noted landscape architect Garrett Eckbo, and was the nation's second downtown pedestrian mall. The design of Fulton Mall is an exemplar of pedestrian-oriented design. For links to further information, please visit http://www.downtownfresno.org/fulton-mall.html.

Davis's Village Homes is a 68-acre development of single-family homes, apartments, a community center and an office building that features solar construction, natural cooling systems, communal agricultural areas, a natural drainage system and a pedestrian- and bicycle-friendly layout. There are more walking and bicycle paths than roads, which lend themselves to evening strolls, toddler bicycle training, roller skating and lemonade stands. All streets end in cul-de-sacs and most streets have pedestrian connections. Building setbacks are 15 feet, to enable enough room for greenways. Bikeways form a grid across the subdivisions, making biking or walking the most direct and quickest way to travel. For more information, visit http://www.villagehomesdavis.org.

HOW TO INCORPORATE TRANSIT INTO BUILDING DESIGN

- **Orient new buildings toward the street and locate them close to bus stops. Eliminate or reduce building setbacks near stops. Avoid making the pedestrian walk across large parking lots. Measure actual walking distances, not straight lines.**
- **Cluster buildings near transit stops.**
- **Include and maintain sidewalks and direct paths between bus stops and rail stations and buildings and residences. Provide shade trees along sidewalks.**
- **Avoid walls around subdivisions that limit direct access to transit. If noise is a problem, use a system of offset walls and berms to control noise while allowing access.**
- **Design building lobbies so that employees can wait for buses and still have a view of the street.**
- **Provide bus shelters, eight-foot wide sidewalks and all-weather pavement at bus stops.**
- **Design streets and intersections on transit routes to accommodate the size and weight of buses. Provide turn-arounds at proper locations to improve on-time performance. Build bus pads at stops to reduce wear and tear on the road.**
- **Build "passenger bulbs" – stop where the sidewalk extends to the traffic/bicycle lane. Bulbs allow buses to stop easily and people are prevented from parking at bus stops.**
- **Consider the transit stop an important destination and an important part of the overall design of a project – not an afterthought.**

To integrate transit and land use planning, the **San Diego Association of Governments** (SANDAG) (land use and transportation planning) was merged with the Metropolitan Transit Development Board (MTDB) (transit operations). The merged agencies now oversee countywide land use and transportation planning where funding priority is given to transportation projects that support smart growth. This program of providing good access to transit through linked bus rapid transit and light rail is called the Transit First Policy.[12] SANDAG Directors provided $1 million in TransNet funding for a Walkable Communities Demonstration Program. Projects in this one-time demonstration program show how walkable communities benefit neighborhoods, increase pedestrian safety, and contribute to smart growth planning. Projects already in construction include the Encinitas Downtown Streetscape Plan, the San Diego 25th Street Corridor Enhancement, the San Marcos Knob Hill In-Pavement Flashing Light Crosswalk System and the El Cajon Downtown Pedestrian Improvements. Contact: Bob Leiter, Department Director of Land Use and Transportation Planning, ble@sandag.org, 619-699-6980 or Stephan Vance, Senior Regional Planner, sva@sandag.org, (619) 699-1924.

Resources

Alameda-Contra Costa Transit District (AC Transit) has published the handbook "Designing with Transit: Making Transit Integral to East Bay Communities" which provides information about designing with transit through planning, creating safe routes to transit and designing streets and bus stops that integrate with transit use. This serves as a toolbox for community agencies working to make their main streets more vital and pedestrian-friendly. http://www.actransit.org/pdf/designing_with_transit.pdf. Contact: Nathan Landau, Transportation Planner, nlandau@actransit.org, 510-891-4792.

The Mineta Institute publication *Construction of Transit-Based Development: New Policy Initiatives for Governments* (September 2001) reviews policies and legislative programs that can be adopted at all levels of government to encourage transit-based development. The study focuses on local government implementation since it is cities and counties that have the land use responsibility for planning and zoning. The study recommends land use, legislative, and fiscal powers that are needed by local jurisdictions to carry out these incentives. http://www.transweb.sjsu.edu

Calgary Transit updated its Transit Friendly Design Guide in April 2006. A manual diagramming basic design strategies for land use as well as transit, it serves as a useful guide for transit agencies and suburban towns interested in designing transit supportive spaces. The guide can be found at http://www.calgarytransit.com/pdf/transit_friendly.pdf.

Florida DOT's publication, "Walkable Communities: Twelve Steps for an Effective Program" summarizes key planning, zoning, engineering, and development strategies that can make communities more walkable. The document addresses walkway networks, pedestrian crossings, access management, auto- and parking-restricted zones, and walkable scale land use planning. Contact: Dwight Kingsbury, FDOT (850-245-1500). http://www.dot.state.fl.us/Safety/ped_bike/brochures/pdf/12STEPS.PDF

Published by the Smart Growth Network, Reid Ewing has authored *Pedestrian- and Transit-Friendly Design: A Primer for Smart Growth,* a booklet with photos and sketches that illustrate some key urban-design solutions. http://www.epa.gov/smartgrowth/pdf/ptfd_primer.pdf

Several transit agencies have put together design guidelines for bus rapid transit, including the land use and service design guidelines that are critical for successful BRT planning. Riverside Transit Agency has assembled the Design Guidelines for Bus Rapid Transit[13] and the Valley Transportation Authority has written a Sustainability Policy and Service Design Guidelines for all modes of transit including bus rapid transit. http://www.riversidetransit.com/downloads/planningGuidelines/RTA_Design_Guidelines_v7.pdf Contact: Jennie Hwang Loft, Public Information Officer, jennie.loft@vta.org, 408-321-5965.

In October 2007, the Florida Department of Transportation published the a "District 4 Transit Facilities Guideline" that assesses streetside and curbsite factors that influence transit accessibility at a site, including positioning of bus stops, curb ramps, pedestrian crossings, and bus bay design. http://www.dot.state.fl.us/transit/Pages/UpdatedD4TransitFacilitiesGuidelines.pdf

The San Diego Association of Governments published *Planning and Designing for Pedestrians: Model Guidelines for the San Diego Region* in June 2002. These model guidelines can be used for a variety of purposes. Local pedestrian coordinators, planners and traffic engineers from towns, cities and the county can work with SANDAG to customize and integrate the guidelines with local level pedestrian plans, land use and transportation policies, ordinances, regulations and street design guidelines. They could also help in pursuing improvements Caltrans roadways. http://www.sandag.cog.ca.us/uploads/publicationid/publicationid_713_3269.pdf.

A simple but interesting application of how pedestrian access to transit and neighborhood amenities is illustrated in a community's "Walk Score." An algorithm which awards points based on the distance to the closest amenity specific categories, such as stores, restaurants, schools, parks, etc. This method can be found at http://www.walkscore.com.

Related Strategies

L.1.2 Land Use Diversity
L.1.3 Transit-Oriented Development
L.3.1 Complete Streets and Street Design
L.4.3 Pedestrian Facilities and Traffic Calming

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FREIGHT MOVEMENT PLANNING

Freight traffic presents a unique set of challenges for local government planners, particularly in California, where the Ports of Los Angeles, Long Beach, and Oakland handle some of the largest volumes of freight traffic in the country. The Ports of Los Angeles and Long Beach are the busiest containerized ports in the United States, handling over 14 million twenty-foot equivalent units (TEU) of freight in 2008.[1] The Port of Oakland handled 2.2 million TEUs in 2008.[2] West Coast ports are predicted to grow 183 percent by 2035.[3] The majority of these shipments were retail imports from Asia, which account for an increasing share of West Coast port traffic and, in turn, truck and rail traffic.

In many California communities, especially those near ports or intermodal centers, motor vehicle-based freight traffic makes up a significant share of roadway traffic. By improving the efficiency of freight movement, communities can reduce energy consumption and help address other environmental problems including air pollution and global warming. The following are examples of ways municipalities can improve the efficiency of freight transportation through public planning, infrastructure investments, and strategic incentives.

General Plan Language Ideas

» Where feasible, the City/County shall designate direct truck routes that promote efficient truck movement while minimizing community impacts of freight movement.

» The City/County shall support efficient and safe movement of goods by rail where appropriate; promote continued operation of freight rail lines and intermodal yards that serve industrial properties and the transport of goods; and promote improved safety and operational conditions for freight rail transport at rail track crossings.[4]

» The City/County shall preserve industrial land for industrial uses and protect viable marine and rail-related industries from competing with non-industrial uses for scarce industrial land. Industrial land adjacent to rail or water-dependent transportation facilities will receive special attention.[5]

Implementation Ideas

Ordinances

Zoning ordinances often specify the location, size, and characteristics of freight facilities within city limits. These ordinances can be updated to improve the efficiency of freight transportation and limit unnecessary energy consumption.

» **Truck routes and weights.** Many cities have ordinances limiting truck traffic of a certain size and weight to specific routes throughout the urban area. Truck route ordinances are intended to limit freight traffic to arterials capable of handling their larger size, and avoiding conflicts with environmentally sensitive areas, schools, residential areas, hospitals, and shopping areas. However, many of these ordinances result in overly long, circuitous routes that subject large, energy-consuming vehicles to unnecessary congestion and longer periods of operation. Ordinances can be revisited to ensure that the most direct routes are being utilized while still keeping community impacts to an acceptable level.

» **Off-peak delivery.** For most less-than-truckload (LTL) freight, delivery generally occurs in morning hours and pick-up occurs in the late afternoon. The new loads are then sorted for delivery the following morning. Off-peak delivery ordinances can be instituted to limit large freight deliveries to hours that will have the least impact on existing vehicle traffic. This can reduce the amount of fuel wasted as a result of congestion and minimize the endpoint traffic backups caused by pick-up and delivery at urban destinations.

- Example: Los Angeles County: "It is the policy of the Board of Supervisors that County departments promote off-peak deliveries and pickup of all commodities by County vendors between the hours of 9:00 a.m. and 3:30 p.m., Monday through Friday, during regularly scheduled County business days... to reduce vehicle trips and emissions during the morning and afternoon commute periods... Departments, as needed, shall advise the Internal Services Department of any on-going violations of any specific terms related to off-peak deliveries that are included in contract awards.[6]"

» **Regional smart growth policies** to balance goods movement with urban residential development. Smart growth policies focus on concentrating residential development in dense urban centers to facilitate transit access, pedestrian and bicycle use, job-housing balances, and lower vehicle miles traveled (see strategies L.1.1 Smart Growth Development, L.1.2 Land Use Diversity, L.1.3 Transit-Oriented Development, and L.1.4 Design Sites for Pedestrian and Transit Access). However, many of the areas slated for residential development are central industrial areas currently used by goods movement industries for local distribution purposes. As these areas adopt more dense residential and commercial land uses, values rise and industrial interests are forced into suburban and exurban areas where vehicle miles traveled (VMT), fuel and labor costs grow as they travel longer distances to serve central corridor markets.

  It is estimated that declining industrial land supply in the central San Francisco Bay Area will force 43 percent of forecasted demand (87,000 jobs) outside of centrally located corridors. This will result in longer routings for an estimated 8,400 daily deliveries, most of which will add congestion to already clogged US-101, I-580, and I-880 corridors.[7] Regional smart growth policy plans can be written to ensure that an adequate supply of land for manufacturing and freight distribution centers in urban core areas, reducing truck VMT while at the same time preserving access to jobs for residents of the urban core.

Subsidizing Alternative Freight Modes

Improving rail and water transportation infrastructure services can help these more energy efficient modes compete with trucking for longer distance hauls. Governments can subsidize rail and marine transportation facilities to encourage alternative freight modes.[8] For instance, the United Kingdom has an explicit policy of strategically investing in new sidings and other improved track access facilities to promote the use of rail as a viable alternative to truck freight, and subsidizes track access charges for privatized rail services.[9]

» **Grade-separated crossings.** At-grade railroad crossings often serve as bottlenecks to freight and passenger rail traffic, slowing shipments and often causing unnecessary congestion on roadways. Installing grade separations between railroads and roadways can alleviate these concerns, allowing rail freight more efficient access to its destinations and maximizing the benefit of additional rail capacity expansion projects.

» **Short-line railroads.** Short-line freight railroads are independent companies that operate over short distances to pick up and deliver freight, often from raw material sources directly to manufacturing facilities. Short-line railroads deliver the equivalent of 26 million truckloads of freight each year, but have faced increasing financial strains and a resulting decline in prominence in recent decades.[10] Supporting short-line railroads that serve locally or regionally important industries can directly benefit a region by shifting freight to a more energy-efficient medium.

Freight Villages

Freight villages (also called logistics parks or intermodal coordination facilities) can ease the shifting of loads from rail, air and water transportation to trucks and vice versa, resulting in more efficient operations. A freight village is an area that consolidates and coordinates intermodal freight activities such as transportation, logistics, and goods distribution. To reduce additional trips, freight villages should consist of support activities such as truck stops and rest areas, storage facilities, office space, retail, and hotels. Freight villages should link multiple modes such as road, rail, waterways, and air transportation, in order to maximize the efficiency of freight handling and transfer.[11] Unifying a freight village under a single management entity can help coordinate operations efficiently.

Urban Freight Consolidation Centers

An urban freight consolidation center (UCC) is a facility, generally on an urban area's periphery, where ground freight shipments from diverse origins are consolidated into a single processing center for all destinations in the city and surrounding area. Consolidation centers consist of smooth interfaces for the easy delivery and transfer of goods to smaller vehicle transportation options for distribution throughout the metro area. Unlike many final destinations, UCCs provide ample room for the unloading of large volumes of goods. UCCs should be located on easily accessible major transportation arteries, to reduce the congestion-related impacts of freight activity.

UCCs offer the greatest efficiency gains by consolidating LTL freight. Most urban areas have multiple LTL terminals serving various subareas. A UCC replaces all LTL terminals in an area, and generally assigns a single carrier to handle all pick-up and delivery (PUD) in the area. The single carrier has the incentive to maximize the efficiency of PUD and minimize vehicle miles traveled.

Potential benefits of UCCs include:

» **Increasing the load factors of vehicles making end destination deliveries.** This limits the number and size of freight vehicles needed for PUD, reducing VMT, unnecessary noise, pavement deterioration, and emissions. It also reduces the unit costs of final delivery for freight companies.

» **Reducing the number of deliveries received at end destinations.** Goods deliveries often cause large transportation network disruption, particularly in dense urban areas. Coordinating final deliveries can reduce the occurrence of such disruptions and/or schedule them for off-peak hours to avoid adverse transportation impacts.

» **Reducing unnecessary time and fuel consumption.** Long-distance drivers often carry light loads. Those who are unfamiliar with their end destinations can waste unnecessary time and fuel searching for single points of delivery. Consolidating long-distance deliveries to a single, accessible center allows drivers familiar with the area to finish delivery.

» **Reducing out-of-stock situations.** UCCs may allow shippers to hold stock at the center, which can reduce the time it takes to order from retail outlets to replenish area shelves. This may also save VMT by reducing the need for multiple long-distance trips by a single carrier.

» **Making urban areas more pedestrian- and bicycle-friendly.** Reducing the number of large, loud vehicles on city roads increases the attractiveness of using non-motorized transportation around those corridors.[12]

UCCs are better suited to some types of goods and vehicle movements than others. Perishable and highly time-sensitive products (e.g., fresh food), and goods with specific distribution and handling requirements are poorly suited for UCCs. In addition, vehicles already carrying full loads for single destinations will not benefit from a UCC. According to available evidence, UCCs are most successful in situations where urban centers are undergoing retail growth, suffering from truck traffic congestion or quality of life related impacts, or conducting major construction projects where consolidation could reduce costs and organize deliveries.[13]

Successful UCCs reduce the number of inner-city stops for long distance heavy-duty trucks, which decreases unnecessary city freight traffic, VMT, emissions, noise, and pavement wear. Incorporating intelligent transportation system (ITS) technologies in UCCs can enable more efficient scheduling and coordination, and can reduce the additional costs UCCs often impose on freight companies. Furthermore, fleet management programs can increase load factors, reduce vehicle mileage, optimize vehicle size for each trip, and reduce unnecessary congestion, pollution, and crash risks.[14]

While UCCs are a new concept in the U.S., a total of 67 UCC programs with evidence of detailed research or in-place operations have been identified in Europe and Japan.[15] In the **Netherlands,** the Ministry of Transportation and Public Works imposes restrictions on vehicle loads and the total number of vehicles entering cities per day. This has resulted in carriers initiating collaborations to consolidate their own shipments and reduce trip volumes. In **Monaco,** the delivery of urban freight is considered a public service, large trucks are banned from the urban center, and all final destination deliveries are handled by a single public carrier.[16]

Impacts

Transportation Impacts

Efforts to improve the efficiency of freight movement can reduce transportation impacts such as road maintenance costs, congestion, road noise, and may also increase levels of bicycling and walking, since the presence of trucks is a deterrent to bicyclists and pedestrians.[17] Heavy trucks can result in road deterioration hundreds of times greater than that imposed by cars, resulting in expensive maintenance costs for cities and taxpayers.[18]

Economic Impacts

Although there are negative impacts associated with freight movement (congestion, air pollution, noise), it is of essential economic importance. More efficient movement of freight not only reduces negative environmental impacts but results in cost-savings for shippers, cargo owners, and businesses.

Energy and Environmental Impacts

Freight transportation consumes roughly 30-40 percent of the total energy used in transportation.[19] In California, freight vehicles consume about four billion gallons of diesel annually. Compared to other freight modes, trucks consume far more fuel and emit larger volumes of harmful emissions per ton-mile. Heavy trucks consume about 25 percent of total roadway fuel.[20] Because of the energy-intensive nature of freight movement, any reductions in truck vehicle miles traveled will yield a greater energy-reduction and pollutant reduction benefit than reductions in passenger vehicle miles traveled.

Shifting freight traffic from truck to rail may also yield environmental benefits for certain types of trips. Recent estimates suggest that reductions on the order of 60 percent per ton-mile may be feasible for shifts to long haul intermodal rail, but reductions in GHG emissions decrease sharply for shorter distance trips, since trucks are usually used at the beginning and ending of the trip.[21] The maximum benefits of shifting from truck to rail are gained for trips of over 1,000 miles.[22]

Rail infrastructure improvements should have air quality benefits. Based on truck and rail vehicles build to the U.S. EPA's most stringent standards, emissions reductions of 27.3 grams per gallon of nitrous oxide (NOx) and 0.891 grams per gallon of particulate matter (PM_{10}) will result from reduced locomotive idling and diverting freight from trucks to rail.[23] On a ton-mile basis, current rail technology produces 14 percent lower NOx emissions than trucks and 74 percent lower particulate matter PM_{10} emissions.[24]

Resources

The Victoria Transport Policy Institute's on-line *TDM Encyclopedia* contains a detailed entry on Freight Transport Management, including policy ideas, implications, and international case studies. http://www.vtpi.org/tdm/tdm16.htm

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PARKING PRICING

The cost of parking heavily influences whether people drive alone, rideshare, or use transit, particularly when going to work every day. Reducing the amount of free parking and adjusting pricing policies for both public and private parking spaces can help to tip the balance toward increased ridesharing, transit, walking and cycling. Under California law, companies that pay for employee parking must offer the equivalent in cash to non-parkers.[1]

Parking pricing and parking supply work in combination. Parking pricing is easiest to implement where parking supply is limited, and is most effective as an environmental strategy if a large proportion of the parking supply is priced. Otherwise, travelers may be able to avoid fees by parking elsewhere.[2] Areas with priced parking can thrive if they are vibrant, attractive areas for people to live, work, and play – which can be supported by minimizing the amount of land devoted to surface parking lots. As a result, achieving priced parking – outside of a few existing employment/activity centers such as the city's central business district (CBD) – should be part of a regional land use strategy to focus growth in compact, mixed-use activity centers where parking can be managed and good alternative transportation services made available.

General Plan Language Ideas

» Prices for hourly, daily and monthly parking in lots operated by the City/County and private entities that receive a permit from the City/County shall be structured to create an economic incentive to use carpools, vanpools, transit, bicycles and walking and discourage long term parking for solo drivers.

» The City/County shall encourage existing employers to "cash out" free parking to provide employees with the option of either free parking or an equivalent cash benefit. When necessary to mitigate the impacts of new development, the City/County shall require employers in new developments to "cash out" free parking, or to pass along the cost of parking to their employees.

Implementation Ideas

» **Undertake a regional or local parking study** that examines the existing supply of parking versus demand, and quantifies the costs of parking to businesses, municipalities, and the public (including environmental costs). Identify locations where parking supply exceeds demand and examine strategies for reducing parking needs through better management via pricing.

» **Reduce the supply of free parking by strategically converting free surface lots and on-street parking to paid parking.** Create "Parking Benefit Districts" with revenues directly benefiting communities.[3] The city of Pasadena provides an excellent example (see Programs in Operation).

» **Educate employers about the benefits of cashing out free parking** or of passing along market-rate parking charges to their employees.

» **Cash out free parking** for municipal employees.

» **Offer incentives to developers.** Allow developers to reduce the amount of parking required in new and existing developments if they charge for parking or include lease clauses requiring tenants to provide a cash-out option. Reduce parking requirements for multifamily developments to less than two spaces per unit so that developers have an incentive to charge tenants for the second space.

» **Require employers to adopt parking charges to encourage alternative travel choices.** Ordinances, conditions, or development agreements can be adopted to require employers to charge reduced rates for carpools and vanpools and "cash out" free parking. For example, an ordinance could require that: "Each employer in the City/County offering free or subsidized parking to any employee shall offer that employee the choice of taking the market value of the parking subsidy as a cash travel allowance if the employee does not take the parking subsidy.[4]"

» **Restructure charges in private parking lots and garages.** Implement a parking tax structured to discourage long-term parking by solo commuters. Apply performance-based parking prices – prices set so that about 15 percent of parking spaces are unoccupied during peak hours.[5] Set parking prices equal to or above transit fares. For instance, charge at least the value of two single transit fares for daily rates, and charge at least the value of a monthly transit pass for monthly rates.[6] Impose a peak-period surcharge for parkers entering in the morning. Through an ordinance or conditional use permits, limit "early bird" specials that only benefit employees working regular hours (e.g., 8 a.m. to 5 p.m.) and require discounts for carpools and vanpools.

» **Use a progressive price structure for parking spaces most convenient to retail and professional offices** to favor short-term users who are often customers of local businesses. For example, charge $1.00 for the first hour, $1.50 for the second hour, and $2.00 for each additional hour.[7] Eliminate long-term and monthly parking leases in these areas that depend on high turnover to do business.

» **Improve metering technology to ensure cost effective, convenient pricing.** For example, use electronic payment machines that accommodate various payment methods and rates and allow drivers to pay only for the amount of time they will be parked without leaving excess time. Charge short-term parking by the minute and long-term parking by the hour.[8]

» **In business, retail and tourism areas, adjust the cost of parking in public lots and meters** to discourage long-term parking for solo drivers, allowing easy access for more customers and visitors.

» **Reduce prices or provide free parking to carpools and vanpools** in areas not in conflict with short term parking needs.

» **Implement permit parking.** To prevent spillover into residential areas of cars from sites that charge for parking, limit on-street parking to two or four hours, except by permit (issued to residents only).

» **Place a tax or fee on parking spaces, with incentives for alternatives.** A per space fee or tax could be levied on privately owned parking spaces at businesses. The tax or fee could be reduced based upon the amount the landowner spends on demand management programs. The reduction could be contingent upon charging for parking and/or providing transit discounts. Funds generated by the tax or fee should be used to provide transportation services and facilities. For example, San Francisco imposes a 25 percent tax on all commercial off-street, nonresidential parking transactions. Revenues are divided between the city's general revenue, public transportation and senior citizen funds.[9]

» **Work with neighboring jurisdictions to implement similar parking policies.**

Transportation Benefits

Motorists spend an average of 3.5 to 13.9 minutes searching for on-street parking, and surveys have indicated that between 8 and 74 percent of urban traffic congestion is the result of vehicles searching for curb parking.[10] Charging employees for parking can reduce driving. Research indicates that if the price of parking is doubled, solo driving can be expected to decrease by 10-30 percent.[11] A 1999 study found that roughly 35 percent of solo driving commuters would switch modes if free parking was raised to $20 per month.[12] Another study concluded that solo drivers in suburban areas without transit who were faced with increased parking costs often switched to carpools and vanpools.[13] Programs that charge for parking should be implemented along with a ride-sharing program that helps employees locate alternatives such as

Surveys have indicated that between 8 and 74 percent of urban traffic congestion is the result of vehicles searching for curb parking.

carpool matching. Transit shuttles, operated by the transit agency or a local TMA, might also be appropriate to improve transportation options in districts where parking is priced (see strategy T.2.2 Transportation Management Associations).

Implementing parking pricing in only one area can simply shift vehicle trips to other more suburban locations with negligible reductions in overall vehicle traffic.[14] See strategy L.2.2 Parking Supply Management for more information.

Energy Savings and Environmental Benefits

According to the National Household Travel Survey, commute travel represents 15 percent of the personal vehicle trips made in the U.S. and 27 percent of all VMT.[15] Nationwide, over 90 percent of employees park free at work.[16] Therefore, the potential impact of parking pricing strategies on gasoline consumption and air emissions is significant. Research has shown that those who must pay for parking at work drive 26 percent less than those receive free parking.[17] The table below shows how pricing strategies would be expected to reduce solo-driving and indicates the maximum reduction in overall personal VMT and gasoline consumption if the strategies resulted in a 20-50 percent reduction in solo driving. For example, if 25 percent of the workers were offered a cash out program and 90 percent of these workers currently drive alone, the overall drive alone rate would decrease to 79-86 percent, resulting in a reduction in overall personal VMT and gasoline consumption of about 1-4 percent.

Percent of Workers Affected	Old Drive Alone Rate	New Drive Alone Rate	Maximum Reduction in VMT and Gasoline
25%	90%	79-86%	1-4%
	75%	66-71%	1-4%
50%	90%	68-81%	3-7%
	75%	56-68%	3-7%
75%	90%	56-77%	4-11%
	75%	47-64%	4-11%

Economics

Given a choice, motorists tend to prefer free parking. However, unpriced parking is not really free – consumers are ultimately burdened with parking costs through higher taxes and retail prices, and reduced income and benefits.[18] In the U.S. there are approximately one to two on-street parking spaces per vehicle, each of which incurs an annual maintenance cost borne by cities. In terms of VMT, these parking spaces have an annual cost of 12 cents or more per vehicle mile. Charging motorists directly for all parking would raise the perceived cost of driving from 17 cents to 29 cents per mile and relieve the public from shouldering much of the financial burden of free parking.[19]

Cashing out free parking usually benefits employees who do not drive alone to work and has a neutral effect on those who continue to drive. Under California tax laws, mass transit, vanpool and carpool subsidies provided by employers are exempt from gross income.[20] While transportation allowances are considered a taxable fringe benefit, the total amount over a year may not impact taxes significantly if this approach is chosen. Under federal law, only transit pass subsidies of $100 per month or less are considered nontaxable fringe benefits, while parking subsidies of up to $175 are eligible for tax exemption.[21]

Employers who provide free parking incur costs, including construction, maintenance, and taxes, in addition to the opportunity costs of converting spaces to uses with higher financial return. Commuter Transportation Services, Inc. found that Southern California firms spent from $26,000 to $377,000 per year on employee parking with a median cost of about $40,000 per year.[22] Employers who help subsidize transit passes can receive a federal tax credit. The cost of providing free or preferential parking for carpools and vanpools also may be claimed as a business deduction.

If additional parking fees are imposed in lots and garages or the rate structure is changed, the new fee structure can be designed to be revenue-neutral or positive – even if the number of long-term parkers declines. This was found to be the case in Chicago where public parking prices were raised 30-120 percent to level with market prices. As a result, the number of all day parkers arriving before 9:30 a.m. declined by 72 percent, total cars parking declined by 35 percent and parking duration decreased. However, revenues at public facilities increased.[23]

A parking tax should raise revenues to cover the cost of tax collection and to partially subsidize trip reduction programs. By doing so, tax revenues are providing transportation options and public opposition may be reduced. One study of King County, Washington (Seattle and vicinity) estimated that a tax of 50 cents per day on all off-street parking used by peak hour commuters would generate nearly $100 million a year.[24]

Programs in Operation

The City of **Pasadena** devised a creative parking policy that directs parking revenues in Old Pasadena to the revival of the commercial district. Old Pasadena was a historic but rundown commercial neighborhood that had no parking meters. Though property owners and merchants were resistant to paid parking, fearing that it would keep even more customers from the struggling area, they agreed to parking pricing in 1993 when the city offered to spend all meter revenue on public investments in Old Pasadena. The parking revenue ($1.2 million in 2001) was enough to cover annual debt service on the $5 million used to revitalize area sidewalks and alleys, and also provided for additional security and marketing campaigns to attract consumers at no additional cost to merchants, property owners, or taxpayers. Old Pasadena's sales tax revenues exceeded those of the neighboring shopping mall, which was demolished in 2001 to make way for additional storefronts such as those in Old Pasadena.[25] http://www.ci.pasadena.ca.us/trans/PARKING Contact: Pasadena Department of Transportation, Parking Division. (626) 744-6470, parking@ci.pasadena.ca.us.

In 2005, **Redwood City** adopted an innovative parking policy that employed new parking meter technologies. Existing meters along the Broadway retail district charged 25 cents per hour, and 12.5 cents per hour just a few blocks away. The city installed new parking meters that charged variable rates depending on the convenience of the parking space and time of day so that pricing matches projected demand. During daytime hours the parking meter rates were roughly 50 cents per hour along the main street, and in the evenings the most convenient spaces were 75 cents per hour. The meters allow customers to purchase additional time from any meter in the downtown area using just the space number from their cell phone or computer. Meter revenue is dedicated to a downtown improvement fund to ensure that the downtown can continue to compete with suburban retail centers that offer free parking. http://www.redwoodcity.org/cds/redevelopment/downtown/parking.html. Contact: Dan Zack, Redwood City Downtown Development Coordinator, (650) 780-7363, dzack@redwoodcity.org.

In 2000, the City of **Santa Monica** became the first city in the nation to institute a mandatory Parking Cash Out program. It applies to any business with at least 50 employees and at least one work site located in the South Coast Air Basin that leases parking, subsidizes employee parking, can calculate the out-of-pocket expenses of subsidized employee parking, and can reduce the number of leased spaces without violating the lease agreement. Employees have the option of continuing to receive subsidized parking or accepting a buy out equal to the parking subsidy and using an alternate mode of transportation. The city's Cash Out program contributes to its emissions reduction requirements mandated by State and Federal clean air regulations. http://www01.smgov.net/planning/planningcomm/cityplanning.html Contact: City of Santa Monica Planning and Community Development Department, (310) 458-8291.

Oregon's Transportation Planning Rule mandates a 10 percent reduction in the number of parking spaces per capita over a 20-year period.[26] Metro, the **Portland** area's metropolitan planning organization, issued an Urban Growth Management Functional Plan, which requires local jurisdictions to implement regional parking ratios through zoning ordinances, and requires the development of blended parking rates where mixed land uses are proposed. Cities and counties under its jurisdiction must provide Metro with a yearly list of the number and location of new parking spaces and proof of compliance with maximum parking standards.[27]

In 2005, **Austin, Texas** created a Parking Benefit District pilot program for a residential neighborhood affected by "spillover parking" (non-residents using free on-street residential parking for neighboring commercial districts). The city installed metering and set strict maximum time limits on the selected streets. Revenue from the meters accrued in a Capital Improvement Project fund dedicated to transportation, pedestrian, and bicycle improvements in the neighborhood. The neighborhood organization can direct the city to use the funds on an as-needed basis, or wait until sufficient funds are generated to begin more capital-intensive projects. https://www.ci.austin.tx.us/parkingdistrict. Contact: Erica Leak, City of Austin, Neighborhood Planning and Zoning Department, (512) 974-2856, erica.leak@ci.austin.tx.us.

Resources

Donald Shoup's *The High Cost of Free Parking* (American Planning Association, 2005) is an excellent resource on parking pricing and proposes new and innovative ways for cities to regulate parking in order to account for its true cost. It is available for purchase on-line and in bookstores.

The Victoria Transport Policy Institute's Transportation Demand Management Encyclopedia offers a detailed on-line resource on parking pricing, suggested policies, and selected case studies: *Parking Pricing: Direct Charges for Using Parking Facilities.* Available on-line at http://www.vtpi.org/tdm/tdm26.htm.

The Metropolitan Transportation Commission offers a Toolbox/Handbook entitled *Reforming Parking Policies to Support Smart Growth: Parking Best Practices and Strategies For Supporting Transit Oriented Development In the San Francisco Bay Area.* The Toolbox contains strategies for managing both parking supply and demand in a smart growth context. http://www.mtc.ca.gov/planning/smart_growth/parking_seminar/Toolbox-Handbook.pdf.

Transit Cooperative Research Program (TCRP) Report 95, Chapter 13: Parking Pricing and Fees (Transportation Research Board, 2004) examines traveler response to the introduction of parking pricing and to changes in the level, structure, or method of application of parking fees. Included are actions that can change the costs to users of parking even without fee changes, notably through elimination of employer parking subsidies and by fee structures that differentiate by modes of parking or travel. Available on-line at http://trb.org/publications/tcrp/tcrp_rpt_95c13.pdf.

The International Parking Institute provides information for parking management professionals. http://www.parking.org

Parking Today is a monthly magazine that also maintains a web site and blog on current parking issues. http://www.parkingtoday.com

Related Strategies

L.1.1	Smart Growth Development
L.1.2	Land Use Diversity
L.1.3	Transit-Oriented Development
L.1.4	Design Sites for Pedestrian and Transit Access
L.2.2	Parking Supply Management
L.4.2	Bicycle Parking and Facilities
T.2.1	Transportation Demand Management Programs
T.2.2	Transportation Management Associations
T.2.4	Ridesharing

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PARKING SUPPLY MANAGEMENT

The price, quantity, and location of parking have a direct impact on travel behavior as well as the characteristics and quality of an area's development. Because parking availability and prices strongly affect how travelers make transportation decisions, management and pricing of parking can be a powerful tool for reducing vehicle miles traveled (VMT), greenhouse gas (GHG) emissions, and automobile dependence, and increasing the use of ridesharing, transit, bicycling and walking.

Most cities approve zoning ordinances that set minimum parking requirements, usually based on standards that assume everyone drives alone, no one takes transit, walks or cycles to the destination, and no trips are generated internally within an area. While the intention is usually to avoid parked cars "spilling over" into neighborhoods, the larger impact is to provide infrastructure and financial incentives that favor driving, Transportation demand management (TDM) programs can reduce the number of people seeking parking, and thus the demand for parking spaces. Pricing parking, providing information and support for other modes, and limiting parking encourages people to use alternative modes to driving to work. Reducing the amount of parking also conserves energy by using fewer energy-intensive construction materials, and by reducing ambient temperatures and air conditioning needs. Providing parking on-street in lieu of off-street parking serves a number of beneficial functions from a trip reduction perspective. It helps support a pedestrian-friendly environment by buffering pedestrians from street traffic, and further enhances the pedestrian environment by reducing the amount of land devoted to surface lots or structures.

Short-Term On-Street Parking at the North Berkeley Bay Area Rapid Transit (BART) station. On weekday mornings, this space is used for pickup of casual carpool.

General Plan Language Ideas

» ____ percent of parking spaces in facilities located within the Central Business District shall be conveniently located spaces designated for carpool and vanpool patrons.

» The City/County shall empower staff to establish pricing and time limits for on-street parking located in designated commercial areas that result in approximately 85 percent occupancy and a turnover rate that is conducive to local business patrons.

» The zoning code shall be amended to exempt new development within the Commercial District from parking minimum requirements, in conjunction with the requirement of provision of transit passes, car share vehicle, shuttles, bicycle amenities and/or other TDM measures, as appropriate for the specific location.

» The City/County shall support the development of a local improvement district (including businesses, residents, and other local stakeholders) that dedicates parking revenue to public improvements and services within the district area. Potential net revenue uses include landscaping, trash receptacles and collection service, street cleaning, pedestrian-scaled lighting, transit and bicycle infrastructure, TDM programs and management of district transportation amenities and infrastructure.[1]

» The Parking Authority shall not construct new or expanded parking facilities unless the transit agency finds that the costs resulting from such construction and the operation of such facilities will not reduce the level of funding to the transit agency from parking and garage revenues to an amount less than that provided for in fiscal year 2008.[2]

Implementation Ideas

» **Require new employers to implement parking cash-out for employees as a condition of local business permit.** Encourage existing employers to implement parking cash-out through outreach and educational campaigns. Implement parking cash-out for city employees.

» **Implement cash out programs in conjunction with transportation demand management (TDM) programs and support for other modes.**

TDM programs can increase the effectiveness of parking supply management strategies.

See strategy T.2.1 Transportation Demand Management Programs for a discussion of various TDM program opportunities. Develop universal transit pass programs for municipal employees, office park employees, college students, and others (see strategy T.1.1 Transit Fare Measures and Discounts).

» **Implement preferential parking for carpool and vanpool patrons.** Setting aside the most convenient parking spaces for carpools and vanpools in business districts and park-and-ride transit stops encourages ridesharing. Developers can be required or encouraged to incorporate preferential parking into new development. Employers can be encouraged to work with building managers to designate preferential stalls as part of their space lease. These strategies can be less effective in areas where transit use is already significant, since it may encourage switching from transit to ridesharing.

» **Reduce or eliminate minimum requirements in parking codes.** Zoning codes often mandate high minimum parking requirements. Typical minimum parking requirements range from 3-4 spaces per 1,000 sq. ft., which far exceeds normal utilization, estimated at an average of 2.2 parked vehicles per square feet.[3] Reducing minimum requirements is particularly appropriate where codes call for more parking than is utilized (such as suburban office parks), in mixed-use developments, and where transit is a viable alternative.

Coordinate reduced parking requirements with allowance for sharing of parking with other uses and/or development on unneeded parking lots for exiting developments.

» **Implement maximum parking requirements in parking codes.** This reduces parking surpluses by limiting the amount of parking developers may provide. Implementing maximum requirements is particularly appropriate in areas of parking surplus, mixed-use developments, and transit-accessible areas.[4]

» **Manage on-street parking in coordination with off-street parking in commercial areas.** On-street parking can be managed, through time limits and pricing, to better accommodate short-term parking, while off-street parking can be managed for long-term parking (e.g., employees). This ensures that parking is available for retail patrons and other short-term visitors, while discouraging commuters to make use of on-street spaces.

» **Allow on-street parking to count against off-street requirements.** If on-street parking is provided, it is logical that off-street requirements can be proportionately reduced. The most common way of doing this is to revise the zoning code to allow a reduction in off-street requirements equivalent to the number of street spaces fronting the particular parcel that is being developed.[5]

» **Implement shared parking policies.** The overall need for parking supply can be reduced drastically if the same parking spaces that serve offices during the daytime can be used to serve restaurant and entertainment patrons in the evenings. Shared parking allows for more efficient use of land and limits unnecessary development costs.[6] The Urban Land Institute has developed a methodology for calculating total parking requirements when two or more uses share the same parking.[7]

» **Implement smart parking technologies.** Use intelligent transportation systems to notify motorists in real-time of available spaces in parking garages, park-and-ride lots, and other parking facilities.

» **Establish off-site or urban fringe parking facilities.** Charge a premium for the convenient spaces near a commercial center and establish shuttle services or pedestrian facilities to enable access from the remote parking facilities. Motorists generally prefer close parking, but many will park further away if they have a chance to avoid paying high parking fees.[8] Ensure that quality information on the presence of remote parking is available.

» **Impose an areawide parking cap.** Micro-level parking management may simply shift travel from the affected location to another nearby area. Areawide parking management policies avoid this pitfall by applying policies evenly over an area. Such a policy might set maximum parking ratios, forbid free-standing garage construction or surface lots, allow new building construction without parking, and revise pricing structures in public facilities, with the cumulative intent of limiting both the demand for and supply of long term parking.[9]

» **Establish a parking spillover monitoring program.** This can include surveys to identify where spillover is a problem, and ways for businesses and residents to report spillover issues.[10]

» **Create Parking Benefit Districts in areas that experience parking spillover problems.** Charge nonresidents for on-street parking in the district and direct the revenues towards improving transit, bicycle and pedestrian accessibility.

» **Increase the capacity of existing parking facilities.** Increase parking supply by using currently wasted areas, changing from parallel to angled parking, and sizing a portion of spaces for motorcycles and compact cars. Small size stalls (275 sq. ft.) require 20 percent less space than average stalls (325 sq. ft). Typically, 25 percent of spaces can be sized for compact vehicles, which results in a five percent increase in capacity compared to all average sized spaces.[11]

- **Tax parking facilities.** Localities can impose taxes on parking spaces owned by businesses and transactions of parking rentals (e.g., 20 percent sales tax on commercial parking transactions).[12]

- **Establish parking management districts (PMD).** Some cities have formed PMDs in densely developed urban business districts to operate parking, set pricing within a defined area, provide enforcement, and in some cases generate revenue for public purposes. The PMD concept is heavily based on shared parking which can serve multiple nearby uses, reducing on-site and total parking needs. The PMD may be administered by a public or nonprofit entity. In a redevelopment area, PMDs are ideally established during the master planning process so that they can influence the location of buildings, land uses, and shared parking.

- **Establish requirements for carsharing spaces in new development.** Car-share spaces can be used to reduce on-site requirements in locations where a market for carsharing exists. A recent summary of carsharing research suggests that, on the average, carsharing programs in the U.S. have resulted in each shared car replacing five private vehicles.[13] While most applicable for residential developments, where carsharing programs can help residents reduce auto ownership, carsharing also can be used at office developments to support alternative mode use, by providing an option for employees' midday travel needs. Carsharing vehicles that are not in use during the daytime can be used by municipal employees (see strategy T.2.5 Carsharing).

- **Allow reductions in parking for commitments to implement travel demand management programs in new development.** For example, Montgomery County, MD allows parking credits of up to 15 percent for office developments that actively participate in the county share-a-ride program and/or provide private incentives for ride-sharing, meeting various conditions.[14] In South San Francisco, Genentech's corporate program provides a $4/day parking cash out in addition to a transit subsidy and shuttle service. The program has resulted in an estimated 8.6 percent reduction in commute-related GHG emissions.[15]

- **Implement new technology.** Allow the use of mechanical lifts, space finding programs, and multispace meters that can accept various forms of payments (e.g., credit cards), and can be monitored remotely for cost savings.

Transportation and Energy Benefits

The availability of cheap and plentiful parking is directly related to the amount of vehicle use. As the number of parking spaces per employee in a business district declines, the use of alternative modes of travel increases.[16] A 1996 study of 49 employer TDM programs showed a

The availability of cheap and plentiful parking is directly related to the amount of vehicle use. As the number of parking spaces per employee in a business district declines, the use of alternative modes of travel increases.

high correlation between scarcity of parking and the existence of market or near-market rate parking fees, and a correspondingly high inverse correlation between scarcity/fees and vehicle trip rates. In particular, TDM programs appeared to reduce vehicle-trip rates by only seven percent at sites with "ample" parking, compared to 29 percent at sites with "scarce" parking. Similarly, vehicle-trip rates were reduced by eight percent in locations with free parking, compared to 18 percent in locations with nominally priced parking and 32 percent in locations with market-priced parking.[17] Studies have indicated that a 100 percent increase in the price of parking will generally result in a 10-30 percent reduction in driving (see strategy L.2.1 Parking Pricing).[18]

Environmental Benefits

Parking facilities consume a significant portion of urban land, and can result in degraded water quality, storm water management problems, and heat island effects. Constructing new structures or surface lots often paves ground that once absorbed and filtered rainwater, and increases storm water runoff, which can pollute water with oil and other contaminants.[19] Reducing the supply of parking can diminish heat island effects that increase the consumption of energy in summer months. Consolidation of parking into multilevel structures, instead of surface lots, makes more efficient use of land and can reduce the environmental impacts per parking space provided.

Economics

Providing parking imposes several costs, including the "opportunity cost" of the land used for parking. In urban infill locations, for instance, each on-site parking space can reduce the number of new housing units or other uses by 25 percent or more.[20] In addition, transportation is the second highest household expense of Americans, primarily due to automobile ownership, maintenance and operation costs. "Unbundling" the costs of parking and housing reduces parking demand, and provides more choices for low income households.

Parking garages are more expensive to construct and maintain than surface parking lots, but can free up space for other valuable development and reduce walking distances in high-density areas. Surface parking can cost as low as $2,000 per space. Structured spaces in California may cost over $30,000 per space.[21] Underground spaces also improve pedestrian mobility but cost even more than above ground structures. Safety-related seismic structural engineering requirements can further increase the cost of parking garages.

Parking spaces also incur operating and maintenance costs. The annual operating cost of providing a single parking space varies, but averages from roughly $380 (for an unattended facility) to upwards of $520 for attended facilities.[22] Costs may vary widely across the State based on the local price of land and any seismic or environmental considerations that may apply.

A comprehensive parking management program that incorporates parking pricing, cashing out parking, unbundling parking from housing, and other strategies, can reduce total automobile trips by 10-40 percent and provide savings to both businesses and consumers.[23]

Programs in Operation

San Francisco has implemented a number of parking policy reforms. Its Transit First Policy limits parking areas to no more than seven percent of a building's total floor space. New buildings must have their parking plan approved in order to receive an occupancy permit. Permits may be issued only for short-term parking, or for a mix of short-term, long-term and carpool parking. San Francisco has eliminated minimum parking requirements, and established a maximum parking ratio for residential units of three spaces for every four units. In addition, the city imposes a 25 percent tax on commercial parking transactions. http://www.sfmta.com/parking. Contact: San Francisco Municipal Transportation Agency, (415) 554-9805.

In 2004, **Pasadena** reduced its parking minimums for new commercial developments within one-quarter mile of a light rail station, and has established maximums that are equal to the minimums. Minimums are reduced by 25 percent (office) or 10 percent (other nonresidential uses) from baselines of three spaces per 1,000 square feet (office) and 3-4 spaces per 1,000 sq. ft. (most retail uses). The city also has reduced residential parking requirements to a maximum of 1.75 spaces per unit in transit station areas. Contact: Denver Miller, City of Pasadena Zoning Administrator, (626) 744-6733.

Between 2004 and 2006, researchers conducted a smart parking field test at the Bay Area Rapid Transit (BART) station in the Rockridge neighborhood of **Oakland**. Smart parking technologies included changeable message signs (CMSs), Internet reservations and billing, mobile phone and personal digital assistant (PDA) communications, and a wireless parking lot counting system. The survey data indicated that smart parking technologies increased BART trips, resulted in 9.7 fewer VMT per program participant. Furthermore, most participants continued to use smart parking services when fees were implemented.[24] Contact: Susan Shaheen, Research Director, Transportation Sustainability Research Center, University of California, (510) 665-3483.

When the D'Orsay Promenade hotel and retail facility was proposed for an economically troubled area of **Long Beach** in 1998, the city's minimum parking requirements would have required the developer to build one parking space per room and four spaces per 1,000 square feet of retail space (302 spaces total). With costs of $16,000 per space, the total construction cost of parking would have approached $5 million, making it infeasible. However, the city's Downtown Parking Management Plan allowed for shared parking. The developer was able to avoid the minimum parking requirement by allowing the hotel and retail areas to share spaces, which reduced the number of required spaces by 84.[25] http://longbeachgov.civicasoft.com/cd/default.asp. Contact: Department of Community Development, City of Long Beach, (562) 570-6841.

Portland, Oregon's Lloyd District is a high-density residential and commercial area outside of downtown. The Lloyd District Partnership Plan, a joint initiative between Portland, the Tri-Met transit agency and 35 local businesses, was implemented in 1997. Its policies included parking pricing for previously free on-street spaces, discounted parking for carpools, discounted transit passes, and various other management programs. In the first year, the district saw a seven percent reduction in the rate at which commuters drove alone; by 2000, the single-occupant driver rate had declined by 26 percent.[26] http://www.lloydtma.com. Contact: Lloyd District Transportation Management Association, (503) 236-6441, mail@lloydtma.com.

Bellevue, Washington planned and built shared parking structures and then offered spaces in these structures to developers at significant discount (less than one half the actual construction cost). This has helped stimulate redevelopment by attracting developers through a significant financial incentive to purchase shared parking in lieu of building their own parking supply at market rates. While the city administers the parking management district, the local Transportation Management Association, the Bellevue Downtown Association, has assumed the responsibility of brokering parking supply. The Association operates transportation management services (called TransManage) for 12,000 employees in 12 buildings. Contact: Kate Johnson, TDM Manager, City of Bellevue, (425) 452-7896.

Resources

Parking Management and Supply: Traveler Response to Transportation System Changes (Transit Cooperative Research Program (TCRP) Report 95 Chapter 18) is a 2003 publication that presents information on how travelers respond to differences in the supply and availability of vehicle parking, including changes that might occur as a result of shifting land-use patterns, changes in regulatory policy, or attempts to "manage" the supply of parking. http://onlinepubs.trb.org/Onlinepubs/tcrp/tcrp_rpt_95c18.pdf

Parking Spaces/Community Places: Finding the Balance through Smart Growth Solutions (EPA, 2006) describes the environmental, financial, and social impacts of parking policies, and offers approaches for implementing new, flexible policies aimed at balancing parking with other community goals. http://www.epa.gov/smartgrowth/parking.htm

The Victoria Transport Policy Institute's on-line *TDM Encyclopedia* contains a detailed entry on parking management, including policy ideas, implications, and United States and international best practices. http://www.vtpi.org/tdm/tdm28.htm

The Metropolitan Transportation Commission offers a Toolbox/Handbook entitled *Reforming Parking Policies to Support Smart Growth: Parking Best Practices and Strategies For Supporting Transit Oriented Development In the San Francisco Bay Area.* The Toolbox contains strategies for managing both parking supply and demand in a smart growth context. http://www.mtc.ca.gov/planning/smart_growth/parking_seminar/Toolbox-Handbook.pdf

Related Strategies

L.2.1 Parking Pricing

T.2.1 Transportation Demand Management Programs

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COMPLETE STREETS AND STREET DESIGN

Traditionally, street design has focused primarily on accommodating motor vehicles. Complete Streets refers to streets designed for all users: motorists, bicyclists, pedestrians, seniors, persons with disabilities, and users of public transportation. The energy it takes to travel between two points is partly dependent upon the length of the route. By providing a network of fully connected streets, shorter, more direct vehicle routes can be used and less energy is expended. If a system of connected and direct bicycle paths and sidewalks accompany those routes, people will be more likely to use energy efficient forms of transportation such as walking, bicycling, and transit. Designing for these nonmotorized modes of travel can reduce vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions.

The California legislature recently passed the Complete Streets Act (AB 1358), which took effect January 2009. The Act requires California cities and counties, upon revision of the circulation element of their general plan, to identify how the jurisdiction will provide for the "routine accommodation" of all users of the roadway, including motorists, pedestrians, bicyclists, seniors, individuals with disabilities, and public transportation customers.

Street design and street surfaces can also have significant impacts on energy usage from sectors outside of transportation. See strategy C.1.3 Cool Communities for more detail.

> ***"It is the intent of the Legislature to require in the development of the circulation element of a local government's general plan that the circulation of users of streets, roads, and highways be accommodated in a manner suitable for the respective setting in rural, suburban, and urban contexts, and that users of streets, roads, and highways include bicyclists, children, persons with disabilities, motorists, movers of commercial goods, pedestrians, public transportation, and seniors."***
>
> *AB 1358, Complete Streets Act*

General Plan Language Ideas

» In all new roadway projects or major reconstruction projects, travel by pedestrians, bicyclists, and transit users shall be accommodated, except where pedestrians and bicyclists are prohibited by law from using a given facility or where construction of bikeways or walkways would be unsafe or impractical. Such facilities for pedestrian and bicycle use shall be designed to the best currently available standards and guidelines.[1]

» All new city transportation improvement projects shall be planned for, designed, and constructed to provide appropriate accommodation for pedestrians, bicyclists, transit riders, and persons of all abilities, while promoting safe operation for all users.[2]

» A fully connected network of bicycle paths and lanes, walking paths and sidewalks shall be provided to directly connect origins and destinations, reduce travel distances and promote safe bicycling and walking to work, shopping, personal business, transit stops and other destinations (the network should appear in the Circulation Element).

» Street networks also shall be designed to maximize passive solar heating and cooling opportunities for structures built on resulting lots, follow natural contours, preserve natural features and avoid excessive stormwater runoff.

» All streets, and residential streets in particular, shall be designed using the minimum pavement width and curb radii feasible, considering projected traffic flow, parking requirements, safety, multimodal accommodations, cost and energy efficiency.

» Within one year, the Public Works Department will conduct a study to evaluate the feasibility of using light-colored paving materials in new streets and repaving projects. As a result of the study, the Council/Board may revise street standards to require such materials.

Implementation Ideas

» **Develop design guidelines for streets, paths and sidewalks,** such as typical cross-sections and intersection treatments appropriate to accommodate all modes in different contexts. Revise traditional street classification systems based purely on function (arterial, collector, local street, etc.) to identify different street types consistent with the context of the area being served as well as the street's hierarchy in the network.

» **Develop guidelines for circulation networks in newly developed areas or locations where existing networks can be retrofitted.** The circulation networks for automobiles, bicycles and pedestrians should provide direct connections between popular destinations. They should also avoid large subdivisions with only one access point, requiring residents from the opposite side to travel long distances every time they leave the area. In addition, longer streets with residences should be oriented east-west to maximize passive and active solar heating and cooling opportunities for the buildings along the street.

» **Require developments to include direct and convenient bicycle lanes, bicycle and walking paths, and sidewalks.** Local governments can require subdivisions of 200 or more parcels to include bicycle paths.[3] (See strategies L.4.1 Bikeways and L.4.3 Pedestrian Facilities and Traffic Calming.)

» **Require development proposals to include a circulation analysis.** This analysis should be used to demonstrate compliance with design guidelines and standards. Where will people be going and by what mode? Make sure facilities are provided to minimize travel distances and encourage walking, biking, and transit.

» **Provide connections where they do not exist.** Analyze the existing network to find out where people go to and from and by what mode. Identify key origins (apartment buildings, offices, etc.) and destinations (shopping areas, public facilities, etc.) and make sure direct routes are possible between the two points. For example, a drainage canal or fence might block pedestrian and bicycle access between adjacent housing and commercial areas. Provide a bridge or opening to allow direct access. Look for worn paths (also known as "desire lines") through dirt or grass for places that need sidewalks. Provide funding for such connections through the capital improvement process.

» **Revise street standards to allow or require narrower streets** by reducing the minimum and/or maximum widths. The following pavement widths are recommended by the American Society of Civil Engineers (ASCE):

- Access streets: 22-24 feet
- Subcollector: 24-28 feet
- Collector: 24-36 feet[4]

Parked cars can be accommodated using on-street parallel parking or intermittent parking bays with angled parking for four or more cars. If necessary, parking can be limited to one side of the street. Use angled parking (and 90-degree parking in particular) sparingly, as they can create line-of-sight problems and potential conflicts for both motorists and bicyclists.

» **Reduce standards for curb radii.** This will lower speeds of turning cars and reduce the amount of time needed for pedestrians to cross the street. The Federal Highway Administration recommends turning radii of 15-25 feet for arterial streets with substantial numbers of turning buses or trucks. Smaller radii are appropriate for local street intersections. Older cities in Europe and parts of the Northeast often have curb radii of 3-5 feet without significant costs to mobility.[5] On streets with bus service, small curb radii may not be feasible. Coordinate policies with transit and emergency service providers.

» **Reduce existing street and lane widths.** Existing streets in commercial and residential areas

Complete streets provide basic accommodation for all road users: pedestrians, bicyclists, transit, freight, personal automobiles, and others.
Image credit: www.pedbikeimages.org/DanBurden.

can be made narrower by enlarging sidewalks. Travel lanes may be narrowed to allow room for bicycle lanes.

» **Use light-colored paving materials.** Concrete is a common alternative to dark asphalt. Light-colored aggregate can be added to asphalt and light-colored slurry or chip seal can be used when resurfacing. In Santa Barbara, old toilets have been recycled into chips for energy-efficient paving material.

Energy Savings

Direct routes save gasoline. Savings will be approximately proportional to the percentage reduction in VMT. A grid street pattern, as opposed to the conventional suburban network of cul-de-sacs and collector streets funneling all traffic to arterials, can reduce VMT within a development by up to 50-60 percent due to more direct routing.[6]

Grid street patterns are not the only way to provide direct connections and cul-de-sacs need not be eliminated altogether. A development with cul-de-sacs and greenbelts can include a separate off-street network of bicycle and walking paths. For every 100 short trips diverted from a car to walking or bicycling, 5-26 gallons of gasoline are saved.[7] And, by providing a combination of cul-de-sacs and through streets, car trips can still be more direct than in developments with single access points. Cut-throughs connecting cul-de-sacs with other cul-de-sacs or with through streets provide bicyclists and pedestrians a more direct route through a development than the cars, and potentially a faster trip.

Reducing street widths can reduce heat build-up and, consequently, energy demand for air conditioning. On a 90 degree day, the surface temperature of asphalt can reach 140 degrees, increasing air temperature by five degrees or more. Each degree increase in temperature can increase peak cooling demand by one to two percent.[8] Narrower, lighter colored, and shaded streets can reduce air conditioning demand by 10-30 percent by reducing ambient temperatures.[9]

An average of 16 percent of the electricity consumed in all United States households is used for air conditioning; this increases to 30 percent of all electricity used in California on hot summer afternoons. Single-family homes use from 950 to 2,700 kWh per year for cooling.[10] A 10-30 percent reduction in cooling needs would save 95 to 810 kWh per year per home (up to $117 per year if electricity costs $0.1445 per kWh[11]) with air conditioning. The energy to produce, lay, and maintain asphalt will also be reduced.

Environmental Benefits

Reducing VMT by providing more direct routes for cars will reduce air emissions, including GHGs. However, unlike gasoline savings, the percentage reduction in emissions will be significantly less than the reduction in VMT. This is because starting a cold engine and turning it off accounts for a significant portion of vehicle exhaust. For example, reducing a five-mile round trip to four miles (a 20 percent reduction) will only reduce emissions by about 8 percent.[12] On the other hand, emissions are reduced 100 percent if the trip is made via bicycle, which is more likely if a safe and direct route is available.

In addition, a street system built around a network of connected greenbelts and bicycle paths can allow for natural drainage, reducing stormwater runoff, the amount of energy used for pumping stormwater, and the amount of pollutants entering the wastewater treatment system.

Decreasing cooling demand will reduce air pollutant emissions from power plants. In fact, the percentage reduction may be higher than the reduction in electricity demand because of the amount of air conditioning used during peak periods when less efficient, more polluting power plants are operating. Summer heat islands, caused in part by dark surfaces that absorb heat, can increase smog production. For each five degree increase in ambient temperature, the incidence of smog events may increase by 10 percent.[13] To the extent that the narrow streets and smaller curb radii encourage more people to walk, pollution from cars also will be reduced. Narrower street widths result in less storm water runoff, due to the reduction in impervious surfaces.

Economics

Providing a bicycle circulation system will involve some costs which may be paid for by the developer in new areas or with public transportation funds (see strategy L.4.1 Bikeways). Costs average between $5,000 and $50,000 per mile for bicycle lanes on both sides of a roadway.[14] Costs for bicycle and pedestrian circulation systems will be lower for new developments than for retrofitting existing areas.

Reducing street widths will reduce construction and maintenance costs. The city of Visalia estimated that reducing street widths by 20 percent could save about 16 percent of construction costs and 12 percent of maintenance costs. Reducing street widths makes land available for other purposes, such as widened sidewalks. Reducing street widths by two feet saves about a quarter of an acre per mile of street reduced.

A well-designed circulation system can reduce some costs. For example, if the street system allows for natural drainage (instead of funneling all runoff into the storm-water system), construction costs will be reduced. In the Village Homes subdivision in Davis, the natural drainage system resulted in savings of about $800 (1975 dollars) per home.[15]

Switching from cars to bicycles and walking shorter travel distances will save residents money – from 14-19 cents per mile just in automobile operating costs and up to 55 cents per mile when ownership costs are included.[16]

By reducing air conditioning demand, residents save money. If savings average 80-360 kWh, residents with air conditioning would save from $11-$52 per house every year, depending on their cost of electricity.[17]

Programs in Operation

In 2007, **Sacramento County** adopted a countywide Pedestrian Master Plan, which contains a list of pedestrian mobility goals, policy guidelines, and a prioritized list of targeted projects. The policy guidelines include implementing pedestrian design guidelines, limiting street widths, constructing bikeways, enhancing maintenance of pedestrian facilities, and developing procedures for analyzing pedestrian and bicycle circulation systems in transportation impact studies. Additional policies include planting new street trees, reducing street parking, and considering context sensitive designs at the outset of new developments. More information available at: http://www.sacdot.com/projects/ADA%20and%20Pedestrian%20Projects/documents/SAC_PED_PLAN_FINAL__042807_Small.pdf.

A system of bicycle paths and greenbelts connects apartment complexes and homes in many neighborhoods in the City of **Davis** to the library, schools, playgrounds, shopping, the community center and other city facilities. From the beginning, paths are included in the planning process. For example, the South Davis Specific Plan provides for greenbelts and bicycle paths. These paths lead to bicycle lanes on arterials, connecting all parts of the city. All new developments and large infill projects must provide bicycle and pedestrian facilities that connect with the existing network, as well as bicycle parking facilities when appropriate.

In 2007, **Charlotte, North Carolina** adopted a series of Urban Street Design Guidelines (USDG) to support its Transportation Action Plan (TAP). The USDG provide a diverse set of street types and flexible designs to be applied to varying types and intensities of land uses in Charlotte, and define a process to ensure that appropriate street types and design elements are used to support specific land development and transportation objectives. The USDG outline specific regulations such as preferred and maximum block lengths and curb radii for different land uses. More information at: http://www.charmeck.org/Departments/Transportation/Urban+Street+Design+Guidelines.htm.

In 2007, the City of **Seattle** adopted a comprehensive complete streets ordinance shortly after including a complete streets provision in a transportation bond measure. The ordinance directs the city to integrate complete streets practices into all Seattle Department of Transportation (SDOT) plans, manuals, rules, regulations, and programs as appropriate. And it specifies that "all sources of transportation funding be drawn upon to implement Complete Streets." The ordinance specifically includes maintenance and operations in the policy; this allows minor improvements for nonmotorized users to be made during routine maintenance and operations projects.

Resources

The National Complete Streets Coalition is a nonprofit advocate for complete streets that maintains an on-line information clearinghouse and provides news updates on communities enacting complete streets policies. http://www.completestreets.org

The Pedestrian and Bicycle Information Center is an on-line database of resources on planning and designing for bicycle and pedestrian access. http://www.pedbikeinfo.org

Best Practices for Complete Streets, published by the Sacramento Transportation and Air Quality Design Collaborative, is a useful guide to Complete Streets elements and success stories. Available on-line at http://www.completestreets.org/

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Kulash, Walter M. et al. (2001), *Residential Streets (Third Edition),* American Society of Civil Engineers (ASCE) is a guide to street widths, geometrics, traffic flow, and other design considerations, as well as intersections, drainage systems and pavement. The book provides street designs that can save on land costs, reduce environmental impacts, and encourage alternative transportation modes. It is available for purchase on-line through ASCE at http://www.asce.org/bookstore.

Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing, by the U.S. EPA and Lawrence Berkeley Laboratories, is a comprehensive source of information for local governments on the benefits, costs, and issues involved in tree planting and using light-colored surfaces on streets and buildings.

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Related Strategies

L.1.4 Design Sites for Pedestrian and Transit Access
L.3.2 Street Trees
L.4.1 Bikeways
L.4.2 Bicycle Parking and Facilities
L.4.3 Pedestrian Facilities and Traffic Calming

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STREET TREES

Planting trees along streets reduces the heat absorbed by asphalt and can reduce the energy used for cooling in adjacent buildings. Street trees can help reduce stormwater runoff and improve air quality by removing and sequestering carbon emissions and particulate matter. They provide a better environment for walking and bicycling and can increase property values.

These street trees in St. Helena, California, help shade passing bicyclists.
Image credit: www.pedbikeimages.org/ Dan Burden.

General Plan Language Ideas

» The City/County shall preserve and maintain existing trees along and in public streets and parking lots and plant and maintain more trees in these areas when funding is available. In addition, the City/County shall amend the zoning code to require street trees in new developments. The objective is to provide shade to at least 50 percent of the street and sidewalk, on a block-by-block basis, at noon on June 21 of each year.[1]

» Existing street trees must be protected during all public and private construction activities. If protection is not feasible, trees must be replaced.

Implementation Ideas

» **Protect existing street trees.** Adopt an ordinance requiring anyone (e.g., developers, utilities) beginning to excavate, demolish, or construct within 15 feet of a public street tree to apply for a permit. Permit conditions can specify methods to protect the tree from damage. If preservation is not possible, require replacement on a one-for-one or greater basis.

» **Require street trees in new developments.** Adopt an ordinance amending the zoning code to require street trees in new developments and trees in new surface parking lots. Developers may be given the option of planting the trees or paying a fee to the city/county to plant the trees. Identify who is responsible for maintenance – the city/county, developer, building owners, and/or homeowners. In addition, coordinate planting between city/county departments to avoid problems, such as having new street trees removed for a sewer replacement project.

The ordinance should be developed in accordance with the California Department of Forestry and Fire Protection's *Guidelines for Developing and Evaluating Tree Ordinances* (see Resources below) and should include the following:

- **Criteria for tree species.** Factors to consider include species diversity, height and span, drought tolerance, preferred climate, maintenance costs, safety, susceptibility to fire, pest and disease control, space requirements, life expectancy and aesthetics. Nonnative or invasive species can have dire consequences for existing foliage. For example, the Norway Maple, long one of the most common street trees planted in the eastern United States, often "escapes" into neighboring woodlands and creates a thick shade that displaces native trees and other plant life.[2] The selection of species native to California and suitable to the city's climate is recommended. Selecting species with spreading, shallow root structures can result in costly damage due to conflict between tree roots and city hardscape.[3]

- **Criteria for allergy and toxicity.** Climate change is expected to increase the length and severity of the pollen season, the occurrence of heavy precipitation events and frequency of urban air pollution episodes, all of which will increase the incidence and severity of allergies and asthma. The greater the exposure to pollen, the greater the incidence of pollen-triggered allergy and asthma. It is important to select trees and landscaping with low pollen allergy potential, which often means planting female plants/trees.[4]

- **Spacing requirements.** A standard of one tree per 40 feet is common, However, higher standards are used in many communities in California. Different locations within a city may face different spacing requirements. For example, along its El Camino Real thoroughfare, the city of Palo Alto requires one tree every 30 feet of nonparking lot frontage and every 25 feet for parking lots.[5] New York City recently passed a requirement mandating one tree every 25 feet in all new developments.[6] Spacing should ultimately be based upon an objective for shade cover, such as shading at least 50 percent of the street in the summer within a specified number of years. Standards for parking lots could be enumerated as [number] trees per sq. ft. or parking space, or as an objective for shade coverage within a certain number of years. Standards for shade coverage should clearly include bike and pedestrian areas.

- **Standards for minimum tree size and location.** Plant trees of adequate size to ensure survival. Trees should be planted to avoid utility lines, building awnings and other conflicts, and to allow appropriate solar access on nearby buildings. Sidewalks and trees must be designed to coexist. Include minimum standards for the size of tree wells, drainage systems and other specifications such as root barriers.

» **Hire or appoint a city forester.** A single person should be in charge of forestry programs, including planting and maintenance of public trees, tree planting requirements for new development, tree protection, street tree inventories and long-range planning. Ideally, this position would work with community services, neighborhood associations, and other groups to engage neighborhoods groups and residents in the maintenance and preservation of trees.

- **Maintain street trees.** Regular maintenance is essential to establishing a healthy urban forest.

- **Conduct inventories and set targets.** Conduct and regularly update a street tree inventory. Inventories support maintenance and protection programs, and allow tracking of progress towards tree-planting targets.

- **Routinely budget for street trees.** Include street tree planting in the capital budget for road building.

Transportation and Energy Benefits

Street trees naturally cool city air, reducing area demand for energy. The evaporation from a single large, healthy tree can produce the cooling effect of 10 room size air conditioners operating 24 hours per day.[7] One Davis study found that evening ambient temperatures in neighborhoods with well shaded streets are up to 10ºF cooler than areas with less shading.[8] Another study found that the air in a two-acre oak forest was seven to nine degrees cooler than the air above a nearby grassy area and 37-39ºF cooler than an asphalt parking lot.[9]

A one degree Celsius change in average summer temperature for a large region could affect total electricity use by one to two percent due to the need for space cooling. Even when increased winter heating needs are considered, a one degree Celsius change could reduce overall electricity use by about .5 percent to over 1.1 percent.[10]

Expanding urban greening and forests are recommended strategies for reducing urban heat island effects and the health threats of extended heat waves that are expected to increase with further global warming. In cooler areas, street trees can serve as wind breaks and reduce the demand for energy to heat buildings. Trees may reduce wind speeds in residential areas by 14-41 percent in the winter, depending upon the land use density.[11]

Numerous studies show that street trees, along with other pedestrian amenities, have been found to promote increased physical activity.[12] Narrow, shaded streets can slow down the cars and be up to 10ºF cooler, making walking far more pleasant. Landscaping and adding trees are significant "traffic calming" features as demonstrated in places like in Birmingham, Michigan, which show reduced speeds of 10-15 mph when street trees are present on same width streets.[13] Traffic calming measures increase the likelihood that residents will walk (rather than drive) to their destinations (see strategy L.4.3 Pedestrian Facilities and Traffic Calming). Increasing physical activity, particularly by expanding active transportation, has significant cobenefits including reducing the risk or improved management of chronic diseases; reduced injuries and crime; reduced greenhouse gas emissions, and more resilient communities.

Environmental Benefits

Reducing electricity demand, particularly peak demand often associated with air conditioning, will reduce pollutant emissions from power plants and greenhouse gas emissions. For every 1,000 kWh of electricity used in California, about 879 pounds of carbon dioxide (CO_2) are produced.[14] The average central air conditioner consumes about 2,305 kWh per year.[15] A single healthy urban tree can absorb up to 50 pounds of CO_2 per year and release enough oxygen into the atmosphere to support two human beings.[16] Trees can also reduce particulate matter and other air pollutants.

Trees directly address climate change impacts by absorbing carbon dioxide. Trees typically absorb several tons of carbon dioxide during their lifetimes.[17] The amount of carbon absorbed depends on tree density per acre, diameter structure, species composition, and growth rates. Each person in the U.S. generates approximately 2.3 tons of CO_2 each year. A healthy tree stores about 2.6 tons of carbon per acre each year.[18] The U.S. Forest Service provides a free calculator for measuring the greenhouse gas reduction benefits of street trees – see the Resources section below.

Trees reduce runoff and erosion from storms by about seven percent and reduce the need for erosion control structures.[19] In urban areas with trees, the use of smaller drainpipes can save cities on materials, installation and maintenance. Rainwater either adheres to the plant surfaces or flows more slowly through the plant. Reducing and/or slowing urban runoff can reduce the size of new treatment systems. In addition, field tests have indicated that properly placed, dense street trees can reduce the apparent loudness of roadways by 50 percent or more.[20]

Economics

The cost of contractor-installed trees in 15-gallon containers (a commonly used size) varies depending on species and contractor fee. In 2000, the average cost of a street tree was $154, but they can be substantially more expensive today.[21] The cty of Brentwood, California paid $230 per tree in 2007.[22] In the case of new development, the cost of planting street trees could be paid by the developer.

In 2003, cities in California spent an average of $19 per tree each year on planting, management and removal of public trees.[23] Budgets for tree programs averaged less than one percent of the city's total operating budget.[24] Nationally, labor costs account for about 70 percent of the average tree care budget. For most programs, each full-time employee cares for between 500 and 5,000 trees.[25] Partnering with nonprofit organizations can reduce the cost of street tree maintenance.

Possible funding sources for planting and maintenance include the general fund, special assessment districts, fines from improper removal of trees, development impact fees, grants, donations and parking taxes and revenues.

Trees can be of significant economic value to both cities and residents. The Rocky Mountain Institute estimates that the average value of a tree over its 50-year lifetime, including air conditioning, soil erosion, storm water control, and wildlife shelter, totals $162,000.[26] A study in Bismarck, North Dakota showed that every dollar spent on a street tree yields $3.09 in benefits,[27] while Boulder, Colorado earns a return of $3.67 for every dollar spent on urban forestry.[28]

Planting street trees raises nearby property values and creates other intangible benefits. One study estimated that street trees in Portland, Oregon increased home values by a total of $1.1 billion – an average of $7,020 per home – and increased the city's annual property tax revenue by $13 million.[29] The USDA Forest Service estimates that Portland, Oregon's street trees reap $45 million in benefits annually, compared to annual maintenance costs of $4.6 million.[30]

A 2003 study conducted by the Center for Urban Forest Research concluded that total annual benefits from street trees in San Francisco are roughly $7.5 million, or $77 per tree. This includes $6.9 million in annual property value increases, $467,000 in reduced stormwater runoff, $189,000 in intercepted air pollutants and particulates, and $86,000 in reduced electricity and gas consumption. Because of San Francisco's moderate summer weather, its energy savings are modest compared to what would be found in warmer inland areas.[31]

In San Diego, annual savings from street trees has been estimated at nearly $11 million in air pollution removal and over $14 million in stormwater runoff savings.[32] New York City estimates savings associated with street trees at upwards of $122 million per year.[33]

Programs in Operation

The Sacramento Tree Foundation is working with the elected officials of the **Sacramento Area Council of Governments** (SACOG) to double the region's tree canopy over the next 40 years. The goal is to maximize the benefits of trees by improving the urban forests in each municipality within the region.

The Greenprint is a call to action and a plan of work for each of the 28 local governments in the six-county SACOG region to adopt tree canopy goals, policies and ordinances, best management practices, and community involvement strategies. Technical advice from arborists, urban foresters, landscape architects, engineers, and policy-makers contributed to a series of best strategies and guiding principles for the final draft Greenprint policy document. To date, 22 cities and four counties or 26 SACOG jurisdictions have signed on to the Greenprint. http://www.greenprintonline.org. Contact: Desiree Backman, Deputy Director, (916) 924-8733, x132, desiree@sactree.com.

The City of **Palo Alto** established a goal to reduce the heat island effects of pavement by shading 50 percent of the street right-of-way with street trees. Developers are required to plant street trees adjacent to new buildings.

A city ordinance requires one tree for every six parking spaces in new parking lots and prohibits having more than 10 spaces in a row without a tree. Funds for the city's tree program and full-time arborist come from the general fund. Contact: City Arborist, City of Palo Alto, 3201 E Bayshore Rd, Palo Alto, CA 94301, (650) 852-9289, pwd@cityofpaloalto.org.

In 2006, the City of **Los Angeles** launched the "Million Trees LA" initiative, with the goal of planting one million new trees in the city. Million Trees LA is a partnership between Los Angeles, TreePeople (a Los Angeles nonprofit), and other community organizations, businesses and individuals. The city worked with the Center for Urban Forest Research in Davis to develop a scientific tree canopy analysis of the city to identify priority areas and suggested species for planting. TreePeople and other nonprofits, corporations, and volunteers, are assisting in the planting effort. The initiative was created as part of a comprehensive climate change action plan to reduce greenhouse gas emissions to 35 percent below 1990 levels by 2030. By the two-year anniversary of the initiative the city had planted over 167,000 new trees. Funding for Million Trees LA was acquired through grants, independent donations, and corporate and foundation funding.[34] http://www.milliontreesla.org. Contact: The City of Los Angeles Department of Recreation and Parks, 1200 W. 7th Street Suite 700, Los Angeles, CA 90017.

The City of **Gainesville**, Florida has adopted a comprehensive landscape ordinance that applies to all property within the city. The ordinance requires that each new development in the city have a minimum number of trees – for sites of five acres or smaller, the ordinance mandates one tree every 2,800 square feet. The code further mandates that no more than 30 percent of existing tree canopy in a development area can be removed, requires developers to plant subdivision street trees, and outlines specific planting requirements for selected "gateway streets." Nonnative and invasive tree species are prohibited. Tree removal permits are required for all trees at least eight inches in diameter at breast height (DBH). The city awards tree credits to developers who preserve trees, with greater credits awarded for older, larger trees. Gainesville also designates "Champion Trees" and "Heritage Trees" for protection. Contact: Jim Garrett, Code Enforcement, City of Gainesville, PO Box 490, Station 10A, Gainesville, FL 32602-0490, (352) 334-5030, codes@cityofgainesville.org.

In 1989, the City of **Tucson**, Arizona launched its Trees for Tucson program to encourage and facilitate desert-adapted tree planting in the Tucson metropolitan area. Thanks in part to a grant from Tucson Electric Power, Tucson area homeowners can receive trees (five gallon size) for $8 each, if they agree to plant them on the east, west or south side of their home. The offer applies to any nonprofits, community groups or individuals who apply to plant trees on neighborhood streets. Over 50,000 trees have been distributed through Trees for Tucson since 1993.[35] Contact: Doug Koppinger, Coordinator, Tucson Clean and Beautiful, PO Box 27210, Tucson, AZ 85726, (520) 250-8220.

Resources

The California Department of Forestry and Fire Protection, Urban Forestry Program, offers technical assistance, a survey of California urban forestry programs, a quarterly urban forestry newsletter, and Guidelines for Evaluating Tree Ordinances. The Urban Forestry Program awards over $1 million dollars in annual grants to plant trees and over $2.5 million for related projects in urban communities throughout California. Four regional Urban Forestry Field Specialists provide expert urban forestry support to communities, nonprofit groups and other municipal governments to create and maintain sustainable urban forests. Contact: John Melvin, State Urban Forester, Department of Forestry and Fire Protection, P.O. Box 944246, Sacramento, CA 94244-2460, (916) 657-2289,John.Melvin@fire.ca.gov.

Under the Environmental Enhancement and Mitigation Program, established in 1989 with the enactment of AB 471, the Resources Agency of California provides grants to local, state, and Federal agencies and nonprofit entities to mitigate the impact of new or modified transportation facilities. Tree planting programs within or outside of the right-of-way of transportation facilities are eligible. Applications are usually due at the end of December for the upcoming fiscal year. http://www.resources.ca.gov/eem Contact: EEM Program Coordinator, Resources Agency, 1416

Ninth St., Suite 1311, Sacramento, CA 95814, (916) 651-7593, eemcoordinator@resources.ca.gov.

California ReLeaf (CR), founded in 1989, is a nonprofit organization that builds strategic partnerships to preserve, protect, and enhance California's urban and community forests. CR promotes alliances among community groups, industry, government agencies, and individuals to plant and care for urban trees. In addition, CR serves as the State's volunteer coordinator for urban forestry and provides urban forestry and tree-planting grant programs on behalf of the Department of Forestry and Fire Protection and the U.S. Department of Agriculture Forest Service. Since 1992 CR has distributed nearly $3 million in grants to nonprofit and community groups for the planting and care of urban trees. http://www.californiareleaf.org.
Contact: Martha Ozonoff, Executive Director, PO Box 72496, Davis, CA 95617-2496, (530) 757-7333, mozonoff@californiareleaf.org.

The Urban Forest Ecosystems Institute (UFEI), developed by the Natural Resources Management Department faculty to address the increasing need for improved management of the urban forests in California, has established a tree selection guide that considers tree attributes for over 1000 tree species including the following health and safety factors: utility precautions; fire safety; root damage potential; invasive plants, hazardous trees, tree maintenance, allergy and toxicity; and biogenic emissions. http://selectree.calpoly.edu

U.S. Department of Agriculture Pacific Southwest Research Station's Center for Urban Forest Research, (CUFR), is a research and development branch of the USDA Forest Service for California, Hawaii, and U.S. Pacific Islands. CUFR develops and delivers scientific information, technologies, and applications to inform urban forestry decisions. CUFR offers a free Tree Carbon Calculator application (http://www.fs.fed.us/ccrc/topics/urban-forests/ctcc/) that quantifies the effects of greenhouse gas tree planting and stewardship projects by producing carbon storage and sequestration values for specific trees, as well as associated energy conservation and emissions reductions. Contact: Greg McPherson, Project Leader, 1731 Research Park Dr, Davis, CA 95618-6132, (530) 759-1723.

American Forests (AF) is the nation's oldest citizens' organization for trees, forests and forestry. In addition to sponsoring the Global ReLeaf campaign, AF established the National Urban Forest Council. The Council publishes Urban Forests, a free bimonthly newsletter. AF also offers American Forests Magazine, publications and videos on tree management, and proceedings from AF's annual urban forestry conferences. http://www.amfor.org. Contact: American Forests, P.O. Box 2000, Washington, D.C., 20013-2000, Phone: (202) 737-1944, info@amfor.org.

The National Arbor Day Foundation promotes tree planting through its Tree City USA program. To be designated a Tree City, a city must: 1) appoint a tree board or establish a tree department; 2) adopt a tree ordinance; 3) spend at least $2 per capita annually on forestry; and 4) issue a proclamation in observance of Arbor Day. The Foundation has a model ordinance and other tree planting information. http://www.arborday.org/programs/treeCityUSA. Contact: National Arbor Day Foundation, 100 Arbor Avenue, Nebraska City, NE 68410-1067, (888) 448-7337.

The Urban Forest Ecosystems Institute (UFEI) is a center for applied research, technology transfer and outreach programs on urban forestry management located at California Polytechnic State University in San Luis Obispo. UFEI works in partnership with the Natural Resources Management Department to provide interactive criteria on tree species selection, and tree pests and diseases. http://www.ufei.org. Contact: Dr. Richard Thompson, Director, UFEI NRM Department, Cal Poly State University, San Luis Obispo, CA 93407, (805) 756-2898, ufei@polymail.calpoly.edu.

The International Society of Arboriculture, a professional organization of arborists, publishes a monthly magazine and guides on establishing tree values, municipal tree ordinances and tree transplanting. Information on tree care and preservation is also available. http://www.isa-arbor.com. Contact: Jim Skiera, Executive Director, P.O. Box 3129, Champaign, IL 61826, (217) 355-9411, jskiera@isa-arbor.com.

Street Tree Seminar, Inc. (STS), is an organization dedicated to the development, health care and management of street trees in both rural and urban areas in southern California. Membership consists of professional tree managers, arborists and associated organizations and companies. STS offers a monthly newsletter and facilitates periodic meetings and forums on street tree related matters. http://www.streettreeseminar.com. Contact: Street Tree Seminar, Inc., P. O. Box 6415, Anaheim, CA 92816, (714) 639-6516, info@streetseminar.com.

Guidelines for Developing and Evaluating Tree Ordinances, by E.A. Bernhardt and T.J. Swiecki, is a manual published by the California Department of Forestry and Fire Protection that provides guidance on types of ordinances, their effectiveness, and developing plans for enforcement, management, evaluation, and garnering community support. It is available in an on-line format through the International Society of Arboriculture. http://www.isa-arbor.com/publications/ordinance.aspx.

U.S. Landscape Ordinances (1998), by D. Gail Abbey, is an annotated reference book describing examples of city ordinances across the country, including those pertaining to street trees.

Pests of Landscape Trees and Shrubs: an Integrated Pest Management Guide, by Steve Dreistadt, is a free guide published by the University of California Division of Agriculture and Natural Resources that includes biological controls of known tree pests, landscape designs that prevent pests, less-toxic pesticides, plant care activities that can prevent potential problems, references, and a suppliers list. The guide is available for purchase on-line.

Related Strategies

L.4.3 Pedestrian Facilities and Traffic Calming
B.1.7 Shade Trees
W.3.1 Water Efficient Landscaping

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BIKEWAYS

Providing a safe and direct network of bikeways can reduce energy use and climate change impacts by shifting some personal vehicle trips to bicycle. Stuides have shown an association between bicycling infrastructure and frequency of bicycling.[1]

Bicycles may be used for any type of trip, but are particularly convenient for shorter trips. According to the 2001 National Household Travel Survey, nearly one half of all trips taken in the United States are three miles or less in length, and 28 percent are less than one mile. Making these shorter trips by bicycle instead of automobile can be made even more attractive by providing safe, convenient bikeways. Bicycle parking and other facilities are discussed in strategy L.4.2 Bicycle Parking and Facilities.

General Plan Language Ideas

» Include a planned network of bicycle facilities in the circulation element, with an implementation schedule. Make sure the network connects residential areas and important destinations, such as employment sites, shopping centers, schools, transit stops and stations and public facilities. Plan to provide bikeways on all arterials.

» New subdivisions of over 200 homes and large employment sites shall include bikeways that connect to the existing network.

» The Public Works Department will maintain public bikeways to assure safety and comfort.

A bikeway in Newport Beach, California.
www.pedbikeimages.org/ Dan Burden.

» New roads shall include bicycle lanes or adequate pavement width to allow shared use.

» Signal detectors responsive to bicycles shall be installed at new and existing intersections and traffic signals shall be timed to allow adequate clearance for cyclists.

Implementation Ideas

» **Encourage compact development** to reduce the distance between destinations and make a greater number of trips convenient for bicycling. See strategy L.1.1 Smart Growth Development for ideas.

» **Create and implement a plan for developing and improving bicycle facilities.** See the city of Berkeley's Bicycle Plan (http://www.ci.berkeley.ca.us/transportation/bicycling/bikeplan/bikeplan.html) and other examples in the "Programs in Operation" section for ideas.

» **Appoint/hire a bicycle coordinator.** A bicycle engineering and planning professional can provide valuable expertise and help ensure the inclusion of bicyclist needs throughout the planning and zoning process. In large cities, this may be a full-time position. A bicycle committee or commission, involving citizens, also can be useful in preparing and implementing a bicycle plan and identifying bicycle needs on an ongoing basis.

» **Amend the subdivision ordinance to require bicycle lanes on arterials and/or a system of paths.** Paths can be required in subdivisions of 200 or more parcels (Govt. Code 66475.1). Include criteria for the system in subdivision design standards. For example, paths that intersect numerous streets, requiring bicyclists to stop frequently, usually are ineffective at promoting bicycling for utilitarian purposes and can be hazardous.

» **Amend zoning codes to require large new employment sites to provide adequate bicycle access.** This would include connections from existing or planned bicycle lanes and paths to bicycle parking areas (see L.4.2 Bicycle Parking and Facilities).

» **Evaluate existing areas for bicycle facilities.** Consider restriping arterials to provide bicycle lanes and/or widening curb lanes, particularly when other roadway work is being done. Providing bicycle accommodations on all roads ensures that cyclists can choose the most direct route. When using widened curb lanes to provide bicycle routes, consider the use of "sharrows" to raise awareness of motorists about the presence of bicyclists.

» **Establish design standards.** Establish standards for bikeways, bicycle lanes, outside vehicle lane widths, shoulders, pavement quality, intersections and other bicycle facilities to improve safety and access. The standards should be consistent with Caltrans' Bikeway Planning and Design Standards (see Resources section).

» **Provide full access.** Provide bicycle access across bridges and freeways and at interchanges, grade separations and other common barriers. On stairways at over- or undercrossings, install slot tracks that accommodate bicycle wheels for walking bicycles up and down the stairs. During road construction, make sure that cyclists can use the roadway safely or that close alternatives exist.

Example of "sharrow" markings.
Photo: Todd Boulanger, City of Vancouver Bicycle Coordinator.

» **Install traffic signals that are responsive to cyclists.** Install and mark signal loop detectors that are responsive to bicycles. Time signals to allow adequate clearance time for bicyclists. AB 1581 (signed October 2007) requires cities and counties, upon first placement or replacement of a traffic-actuated signal, to install signals that detect bicycle traffic.

» **Establish education programs.** Teach safe riding techniques to children and adults through schools, worksites and general publicity efforts. Public education programs also can teach motorists and cyclists how to share the road. Encourage police departments to enforce bicycle vehicle code regulations and motor vehicle code regulations related to bicyclists, and offer bicycle traffic school to violators. Implement training programs for police officers about the rights and responsibilities of bicyclists and motor vehicle operators as they relate to motor vehicle-bicycle interactions (see Resources section for ideas).

» **Provide bicycle maps.** Maps of the community identifying Class I, II, and III facilities should be distributed free throughout the municipality, including employers, bicycle shops, public buildings and schools.

» **Provide regular maintenance and avoid creating hazards.** Maintain the pavement and shoulders on all streets, not just designated bicycle lanes and paths. Provide bicyclists with a phone number to report problems in bikeways. When streets are repaired and patched, require high compaction and maximum smoothness. Avoid inadvertently creating new hazards and eliminate existing ones, including utility hole covers or pavement cuts for underground utilities that result in uneven paving.

Energy Savings and Environmental Benefits

Longitudinal intervention studies have demonstrated that improving bicycling infrastructure is associated with increased frequency of bicycling. Cross-sectional studies indicated a significant association between bicycling infrastructure and frequency of biking.[2]

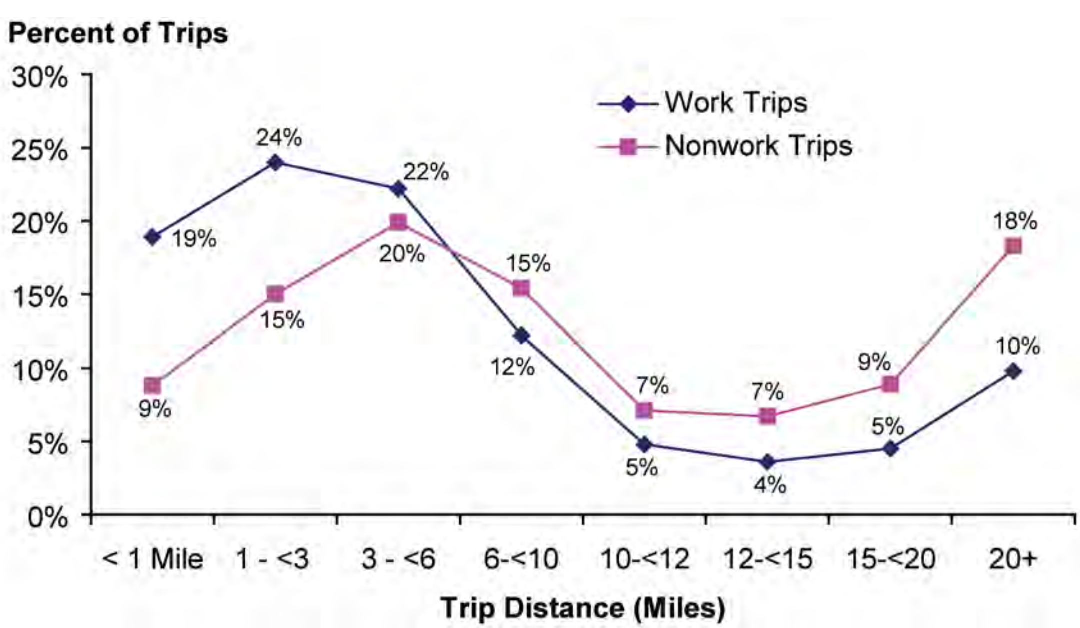
According to the 2001 *National Household Travel Survey*, nearly one half of all trips taken in the United States are three miles or less in length, and 28 percent are less than one mile (see figure below).[3] It is possible to make most of these trips by bicycle. The types most frequently made by bicycle include social, family and recreational trips; trips to schools and churches; light shopping trips; and trips to and from work.

When combined, trips of five miles or less represent over 60 percent of all vehicle trips and over 18 percent of the vehicle miles traveled (VMT). Therefore, if just five percent of these trips were made by bicycle instead of car, three percent of all personal vehicle trips and almost one percent of all personal VMT and gasoline consumed would be eliminated. Because short car trips cause disproportionately high emissions, the reduction in air emissions from personal travel would be one to three percent.

Bikeways will be most successful in reducing automobile travel in communities with complementary policies such as bicycle parking, shower and lockers at job sites, trip reduction ordinances and a compact mixture of land uses.

Economics

The American public saves 5-22 cents per automobile mile displaced by walking and bicycling through reduced pollution, oil import costs, and congestion-related costs such as lost wages and job hours.[4]



Distribution of Vehicle Trips by Length in the United States.
Source: National Household Travel Survey, 2001.

Programs in Operation

The City of **Davis** has long been famous for its bicycle use – 17 percent of all commute trips in Davis are made by bicycle. Davis was one of the first cities in the United States to actively start planning for and incorporating the bicycle into its transportation infrastructure. Davis has had a city/university bicycle map in one iteration or another since the 1970s. It is the only U.S. city with two bicycle coordinators (one for the city and one for the university). While the large university student population and flat terrain contribute to the high bicycle use, the city's commitment to providing bicycle lanes, paths, turn lanes, and detection loops is also a meaningful factor. This is revealed by the fact that bicycle use by junior high and high school students is two and eight times higher, respectively, than in nearby Woodland, a town with the same terrain and weather but fewer bicycle facilities.

Davis' circulation element of the general plan includes bicycle policies, and the city's street standards require that bicycle facilities be considered in the design of all arterial and collector streets. About 95 percent of its arterials and collectors have bicycle lanes. Bicycle lanes must be seven feet in width and bicycle paths must be 10 feet wide. Davis features more than 100 miles of streets with bicycle lanes, bicycle paths, and other bicycle routes. The city also maintains a strong safety program, including bicycle curriculum and safety training in schools.[5] More information available at http://cityofdavis.org/bicycles.

The City of **Folsom** has taken steps to prepare a comprehensive bikeway plan that involves a network of integrated bicycle facilities. Since its adoption in 1999, developers have committed to constructing more than 20 miles of bicycle lanes along new and expanding roads.[6] More recently, the city has committed to spending roughly $8 million in bicycle improvements as part of the new Folsom Dam Bridge/Road Project, with the cooperation of the Army Corps of Engineers and the U.S. Bureau of Reclamation. Among the improvements are the addition of new full-width bicycle lanes over the bridge, and a separated Class I Bikeway along the length of the bridge and its approaches. The new bikeways will connect Folsom's existing bikeways with the 30-mile Regional American River Bicycle Trail, providing bicyclists with direct access to downtown Sacramento. http://www.folsom.ca.us/depts/parks_n_recreation/bicycle_trails/default.asp

The City of **Palo Alto** dedicated its bicycle route system in 1972, one of California's first. The system is based upon the Bikeways Master Plan and includes over 30 miles of bicycle lanes, 7.5 miles of off-road paths, 11 bicycle bridges, and numerous parking facilities.[7] Bicycle use is high in Palo Alto – over 5.6 percent of its workers commute by bicycle according to the 2000 Census.

Palo Alto's general plan identifies implementation programs for completing the Bikeways Master Plan, developing bicycle boulevards, removing traffic control impediments and physical barriers to bicycle travel, requiring bicycle storage facilities, improving safety near schools, encouraging educational programs, and developing bicycle routes in industrial areas. In 1982 the city established a bicycle boulevard on an existing street by removing or reversing stops signs and installing barriers to discourage through automobile traffic. As a result, bicycle travel on the street increased dramatically and accidents were reduced.[8] In 2004 Palo Alto completed a $5.1 million Caltrain rail undercrossing tunnel specifically for bicyclists and pedestrians. The city has a policy to install bicycle detection loops at signalized intersections and distributes a flyer to residents about how to use bicycle detection loops correctly. Palo Alto also offers youth and adult bicycle education and safety programs.[9]

Resources

The American Association of State Highway and Transportation Officials (AASHTO)'s *Guide for the Development of Bicycle Facilities* (1999) is a detailed guide on the planning and design of bikeways, and other bicycle improvements. The Guide contains suggested alignments, widths and surface materials, and safety factors. http://www.sccrtc.org/bicycles/AASHTO_1999_BicycleBook.pdf

The Victoria Transport Policy Institute's *TDM Encyclopedia* entry, "Cycling Improvements: Strategies to Make Cycling Convenient, Safe, and Pleasant" (continually updated) provides examples of bicycle mobility improvements, summarizes studies of their effectiveness, and outlines several national and international bikeway improvement case studies. http://www.vtpi.org/tdm/tdm93.htm

The *California Manual on Uniform Traffic Control Devices* (MUTCD) amends the Federal Highway Administration's MUTCD to comply with state guidelines on the design, placement, and identification of traffic control systems, including those related to bicycles. http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd/CaliforniaMUTCD.pdf

The Pedestrian and Bicycle Information Center (PBIC) web site, funded by the U.S. Department of Transportation and operated by the University of North Carolina Highway Safety Research Center, offers examples of model bikeways and other bicycle facilities, bicycle maps, conference events, and frequently asked questions for transportation professionals. http://www.bicyclinginfo.org

The California Department of Transportation (Caltrans) Bicycle Facilities Unit provides technical advice and information on state funding sources. Contact: Ken McGuire, Bicycle Facilities Unit, Division of Local Assistance, (916) 653-2750, Ken.Mcguire@dot.ca.gov. Local Caltrans districts also have bicycle offices.

The *California Bikeway Planning and Design Standards* (last updated September 1, 2006) outline Caltrans selection, planning, and design criteria for bicycle facilities in California. They are outlined in the *Highway Design Manual,* "Chapter 1000: Bikeway Planning and Design." http://www.dot.ca.gov/hq/oppd/hdm/pdf/english/chp1000.pdf

The Federal Highway Administration's *University Course on Bicycle and Pedestrian Transportation* (2006) contains a series of comprehensive modular resource materials on planning and design of bicycle and pedestrian facilities. Chapter 15, "Bicycle Lanes," presents bicycle lane best design practices and summarizes a number of innovative designs and concepts that are still under evaluation. http://www.tfhrc.gov/safety/pedbike/pubs/05085

Chicago's Bike *Lane Design Guide* (PBIC, 2002) is a helpful resource for the planning and design of bikeways in urban areas. http://www.activelivingresources.org/assets/chicagosbikelanedesignguide.pdf

MassBike has developed a course for police officers on enforcing bicycle laws and regulations. See the Law Officer's Guide to Bicycle Safety, http://www.massbike.org/police.

Funding Sources

Providing bicycle facilities will involve some costs, which may be paid for by the developer in new areas or with public transportation funds. Costs for bicycle and pedestrian circulation systems will be lower for new developments than for retrofitting existing areas. Costs vary, but average roughly $400,000 per mile for a two-way, eight-foot wide separated bicycle path with two-foot graded shoulders (Class I),[10] and between $5,000 and $50,000 per mile for the installation of a bicycle lane, depending on pavement condition, lane painting needs, signalization adjustment, and other factors.[11] Widening a roadway by 2-3 feet with 6-inch fog lines to improve bicycle access may raise this cost to $150,000 per mile or more, depending upon the need to purchase right-of-way.[12] In some cases where travel, parking, and/or shoulder lanes have excess width, bicycle lanes can be fit within the existing footprint of the roadway at minimal cost.

Possible funding sources include:

» **California's Transportation Development Act** dedicates 0.25 percent from the 7.75 percent State sales tax to support public transit. The funds are returned to the county of origin where the regional transportation planning agency may set-aside up to two percent for bicycle and pedestrian projects.[13]

» **Federal Funds.** Bicycle lane and path construction may qualify for a number of Federal programs, such as the Federal Congestion Mitigation and Air Quality Improvement Program (CMAQ) funds, the Transportation Enhancements Program, the Safe Routes to Schools Program, and several other programs. For a list of programs and eligibility criteria, see http://www.fhwa.dot.gov/environment/bikeped/bp-broch.htm#funding. Additionally, California allocates 1/3 of its Federal Hazard Elimination funds to projects that encourage kids to walk and bicycle to school.[14]

- **The Surface Transportation Improvement Program** (STIP) is California's principal capital transportation project funding vehicle, and 75 percent of STIP funds are distributed through Regional Transportation Improvement Programs (RTIP). Regional planning agencies may submit proposals to the California Transportation Commission.[15]

- Caltrans administers the **State Bicycle Transportation Account,** which provides several million dollars per year to local governments to improve the safety and convenience of bicycle commuters. Eligible projects include bicycle paths, lane or route construction and maintenance, lockers, racks on transit vehicles, planning and safety education. Contact the Caltrans Office of Bicycle Facilities.[16]

- California has a state funded **State Safe Routes to School** (SR2S) program that funds bicycle lanes, bicycle parking, new or improved traffic signals, or traffic calming projects, provided that projects have a school nexus. All K-12 schools are eligible for SR2S dollars. Funding levels are set during the annual State budget process and fluctuate from year to year.[17]

- Bicycle lanes may be eligible for **Community Development Block Grants** through the U.S. Department of Housing and Urban Development, if they are a component of commercial district streetscape improvements, safe routes to school, or neighborhood-based bicycling facilities that improve local transportation options or help revitalize neighborhoods.[18]

Other potential sources include developer impact fees, parking surcharges or taxes, county half-cent sales tax funds, and motor vehicle registration surcharges.

Related Strategies

L.1.1 Smart Growth Development
L.3.1 Complete Streets and Street Design
L.4.2 Bicycle Parking and Facilities

Endnotes

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17. Federal Highway Administration website. Accessed July 2009. http://www.fhwa.dot.gov/environment/cmaqpgs/index.htm.
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BICYCLE PARKING AND FACILITIES

In addition to a network of safe roadways and bikeways, cyclists need secure parking at their destinations. Facilities for changing and showering at job sites also can encourage more cycling to work. Local governments can require and encourage these facilities in new developments and existing areas.

General Plan Language Ideas

» All City/County facilities shall include an adequate amount of secure bicycle parking for employees and visitors.

» The City/County shall require new employment centers, commercial buildings and multifamily housing to include adequate and secure bicycle parking. Large employment sites shall be required to include showers and lockers for employees.

» The City/County shall identify existing commercial areas that need additional bicycle parking and pursue installation. This will include City/County purchase and installation of bicycle racks or lockers in public areas, along with encouraging existing building owners to install racks and lockers. Public installation shall include park-and-ride lots, transit stops and transit stations.

Bicycle Lockers at the Caltrain station in Sunnyvale.

Implementation Ideas

» **Amend the zoning code to require secure bicycle parking.** Requirements are usually expressed as a ratio between bicycle and automobile parking – one bicycle parking space for every 10 vehicle spaces, for example. However, if vehicle parking requirements are reduced to encourage the use of alternative modes (see strategy L.2.2 Parking Supply Management), this method may result in too few spaces for bicycles. Standards can be based on the expected number of employees and visitors to the site or the building's size. The code also should establish design specifications (e.g., adequate clearance, safe and convenient location). Lockers are best for long-term parking by employees. Racks are adequate for short-term parking. Requirements should apply to most land uses, including multifamily housing, retail, entertainment, recreational uses, and employment sites. Exceptions could include gas stations and other uses unlikely to need bicycle parking.

» **Provide parking at municipal facilities.** Bicycle lockers should be installed at all facilities for employees. Conduct a survey to estimate use to determine the number to install. Install secure racks at all public facilities.

» **Support bicycles and transit.** Work with the transit agency to install bicycle racks and lockers at rail stations, park-and-ride lots, and bus transit centers, and to provide bicycle racks on buses.

» **Require showers and lockers in new developments.** Revise the zoning code to require large new commercial and industrial developments (e.g., over 10,000 or 50,000 square feet) to provide shower and clothes locker facilities.

» **Install bicycle parking in existing areas.** Install bicycle racks on public sidewalks and in public parking areas in downtown and other commercial areas. Work with businesses to install parking at existing employment sites. Provide building owners with information on parking options. Include bicycle parking as a requirement in a trip reduction ordinance.

» **Encourage employers to provide additional support facilities and incentives.** Employers, including the city/county, could loan tools for repairs when needed on-site, offer bicycle helmets and lights to bicycle commuters, sponsor speakers on cycling, reimburse employees for use of personal bicycles for business travel, and offer company-owned bicycles for business travel. (See strategy T.2.1 Transportation Demand Management Programs.)

» **Establish a "bicycle station."** Bicycle stations can provide a variety of supporting facilities including secure parking, rentals, showers and lockers, information, repair services, and ancillary retail uses. They should be located in major activity centers, such as business districts or transit hubs that have the potential to attract many cycling trips. They can be run by public, private, or nonprofit entities.

Transportation and Energy Benefits

Less than one percent of all trips are made by bicycle in the U.S. However, 59 percent of all trips are five miles or less (one-way), representing 17 percent of the total vehicle miles traveled (VMT).[1] If just five percent of these trips were made by bicycle instead of car, VMT would drop by nearly one percent. Fuel use would probably drop by more than one percent because short trips at slow speeds are less fuel efficient than longer trips at higher speeds. If a commuter traveling five miles each way switched from driving alone to bicycling an average of three days per week, about 40 gallons of gasoline would be saved per year.[2] If transit riders switched from driving to the rail station or park-and-ride lot to bicycling, additional fuel savings would be possible.

With adequate facilities and a network of bicycle lanes and paths, bicycle use at employment sites can be quite high. Thanks to an extensive bikeways network and on-site bicycle parking and showering facilities, nearly 20 percent of the Xerox Research Center employees in Palo Alto bicycle to work.

Environmental Benefits

Bicycling is especially effective at reducing the emissions associated with shorter commutes because these shorter trips are, mile for mile, the most polluting. For example, over 60 percent of the emissions from a five-mile round trip come from starting and turning off the engine, if the engine is cold when started.[3]

According to the 2001 *National Household Travel Survey,* nearly one half of all trips taken in the U.S. are three miles or less in length, and 28 percent are less than one mile.[4]

Encouraging cycling to transit stations will yield additional benefits. If an employee switches from driving alone to using transit two days a week emissions will only be reduced by about 10 percent if the person drives a car one mile each way to and from the transit stop. In contrast, emissions are reduced 40 percent if the person bicycles to the transit stop.[5]

Economics

The cost of installing bicycle parking will depend upon the type of parking and the location. Costs will be lower if bicycle parking is included in the building's original design. Bicycle racks average $150-$300 (for two spaces each) and lockers average $1,000-$4,000 per double unit.[6] These costs are generally far less than the cost of automobile parking, which can range from $2,200 to over $20,000 per space, (see strategy L.2.2 Parking Supply Management). Bicycle rooms and cages cost less than bicycle lockers, provide more security than bicycle racks, and can accommodate more bicycles per area. The cost of installing two changing rooms and shower stalls at a new development may cost $24,000.[7] If a health club is included in the office development, access to the showers and lockers could be made available to bicycle commuters.

Programs in Operation

The City of **Palo Alto** requires specific amounts of high security bicycle parking for most land uses, usually 10 percent of the number of auto parking spaces. One space per unit is required for apartments. Employee shower facilities must be provided in new medical, professional, financial and general business office buildings and additions over 10,000 sq. ft. New buildings and additions over 25,000 sq. ft. used for retail, personal, and eating and drinking services must also provide showers. Bikestation Palo Alto, located at Palo Alto's Caltrain station, was recently refurbished through a grant from the Caltrans Bicycle Transportation Account. It is equipped with 24-hour electronic key access and a double-tier bicycle rack that can accommodate up to 96 bicycles.[8] Contact: Gayle Likens, Transportation Division, City of Palo Alto, (650) 329-2136, gayle.likens@cityofpaloalto.org.

Of **Santa Cruz**'s 27,312 commuters, 4.7 percent commute by bicycle (excluding students). The city of Santa Cruz requires that bicycle parking facilities accommodate a volume of bicycles no less than 35 percent of the auto spaces required at public recreation areas, park and ride lots, and

Bicycle parking in Davis, California.
Image credit: www.pedbikeimages.org/ Dan Burden.

transit centers; 15 percent of the auto spaces at commercial, industrial, office and retail facilities; and one space per three students at schools. In addition, Santa Cruz has recently converted over 100 downtown area bicycle lockers to smart card lockers, which can be rented for three cents per hour with a $20 smart card.[9] Contact: Department of Planning and Community Development, City of Santa Cruz, (831) 420-5100, cityplan@ci.santa-cruz.ca.us.

Resources

The American Association of State Highway and Transportation Officials (AASHTO)'s Guide for the Development of Bicycle Facilities (1999) is a detailed guide on the planning and design of bicycle improvements, including bicycle parking amenities. http://www.sccrtc.org/bikes/AASHTO_1999_BikeBook.pdf

Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planning and Engineers (2005), is a detailed source on standard and innovative practices for both bicycle and pedestrian facilities. It includes suggested location criteria and guidelines for bicycle parking facilities, lockers, racks, and bicycle stations. http://www.dot.ca.gov/hq/traffops/survey/pedestrian/TR_MAY0405.pdf

The California Department of Transportation (Caltrans) Bicycle Facilities Unit provides technical advice and information on state funding sources. Contact: Ken McGuire, Bicycle Facilities Unit, Division of Local Assistance, (916) 653-2750, Ken.Mcguire@dot.ca.gov. Local Caltrans districts also have bicycle offices.

The Victoria Transport Policy Institute's *TDM Encyclopedia* entry, "Bicycle Parking" (continually updated) provides examples of bicycle parking, storage, and changing facilities, and outlines several case studies. http://www.vtpi.org/tdm/tdm85.htm.

The Pedestrian and Bicycle Information Center (PBIC) web site, funded by the U.S. Department of Transportation and operated by the University of North Carolina Highway Safety Research Center, offers examples of model bicycle parking and other facilities, suggested engineering specifications, and frequently asked questions for transportation professionals. http://www.bicyclinginfo.org.

The City of Cambridge, MA has developed a Bicycle Parking Guide that provides zoning language as well as examples of good and unacceptable racks, dimensions for rack spacing, location considerations, and short-term versus long-term considerations. http://www.cambridgema.gov/cdd/et/bike/index.html.

Regional ridesharing agencies often provide information on bicycle commuting.

The U.S. Department of Transportation's Bicycle and Pedestrian Program offers additional information at http://www.fhwa.dot.gov/environment/bikeped.

Related Strategies

L.1.1 Smart Growth Development
L.4.1 Bikeways
T.2.1 Transportation Demand Management Programs

Endnotes

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PEDESTRIAN FACILITIES AND TRAFFIC CALMING

The ideal environment for pedestrians is one in which destinations are accessible within a short walking distance; adequate infrastructure is available; and the area is pleasant, safe, and secure. Unfortunately, many development patterns maximize convenience for the automobile driver, not the pedestrian. Long, winding subdivision streets often eliminate direct routes to destinations for pedestrians and encourage automobile travel at the expense of other modes. A suburban pedestrian often must travel a route five times longer than the direct distance.[1]

While paths are often provided for recreational walking, these routes generally do not link residential areas with common destinations. Pedestrian facilities (sidewalks, paths, crosswalks, etc.) must be provided and amenities (benches, landscaping, fountains, etc.) can further increase the attractiveness of walking relative to other modes.

In addition to convenience, safety and security are also a concern for pedestrians. Collisions with pedestrians account for about one out of every 10 fatalities in motor vehicle accidents in the United States.[2] Traffic calming measures such as narrowing streets, increasing curb radii, and installing mini-circles, speed humps and raised intersections, can slow vehicle traffic and signal to drivers that pedestrians are present. If implemented correctly, traffic calming measures will only modestly reduce the convenience of driving while offering pedestrians a safer, more attractive route to their destinations.

Pedestrian only streets in San Luis Obispo.
Photo: www..pedbikeimages.org/Dan Burden

General Plan Language Ideas

» It is the objective of the City/County to: 1) make walking a reasonable alternative to vehicles for short trips; 2) make walking in combination with transit a reasonable alternative for longer trips; and 3) provide accessible pedestrian facilities for all residents and visitors, including the mobility-impaired.

» The City/County shall develop a master plan for pedestrian facilities and amenities in new and existing areas of development. [Include the plan in the Circulation Element.] Elements of the plan shall be incorporated into all applicable zoning, building, and subdivision regulations. Objectives are to:

1. Provide safe and convenient pedestrian links between residences, transit stops and commercial, public, educational and recreational activities.

2. Ensure that pedestrian routes are direct and free of barriers, including barriers to the blind and mobility-impaired.

3. Reduce accidents between and among motor vehicles, pedestrians, and bicyclists.

4. Clearly delineate safe pedestrian routes.

5. Provide sidewalks, paths and walkways with reasonable grades, adequate clearance, safe lighting and interesting landscaping and streetscapes that reinforce neighborhood identity.[3]

» All new development shall include direct, safe and pleasant pedestrian routes connecting new and existing origins and destinations.

» The City/County shall seek the cooperation of existing property owners to improve pedestrian facilities and amenities in developed areas according to the master plan.

Implementation Ideas

» **Establish a "Pedestrian Master Plan"** that can guide pedestrian policies, projects, and priorities for the city, or incorporate a pedestrian element into the Master Plan. The plan should include: 1) a pedestrian circulation network; 2) design guidelines and standards for pedestrian facilities (sidewalks, crosswalks, etc.) and amenities (landscaping, benches, etc.); and 3) a detailed list of steps to implement the plan, including responsible departments, funding and deadlines. Address the Americans with Disabilities Act and needs for fire and police access. Develop more detailed plans for areas needing special coordination. This could include the downtown, a transit station, shopping mall, school zone, or office park.

» **Shorten distances to destinations.** Distances to destinations must be short to encourage walking. Strategies L.1.2 Land Use Diversity and L.1.4 Design Sites for Pedestrian and Transit Access describe ways communities can encourage compact, mixed-use development that is convenient for walking and bicycling. The degree of mixed uses and walkability in an area can be quickly approximated by visiting the web site http://www.walkscore.com, which rates the walkability of any address on a 0-100 scale.

Narrow sidewalks or sidewalks overtaken by vegetation may force pedestrians to walk dangerously close to vehicle traffic.
Photo: www.pedbikeimages.org/Dan Burden

» **Designate a pedestrian expert.** At least one person within the local government should be responsible for pedestrian planning, including: preparing pedestrian plans and studies; reviewing development plans to ensure pedestrian access; reviewing street construction and reconstruction plans to ensure that pedestrians are adequately accommodated; and responding to citizen inquiries.

» **Appoint a citizen task force.** The task force can help develop pedestrian plans, review development proposals and street reconstruction plans, and perform sidewalk inventories and "walking audits" or other planning tasks.

» **Improve existing areas.** Install amenities, fill gaps in sidewalk links and perform other enhancements identified in the master plan. Construct sidewalk "chokers" or bulbs that reduce crossing distance at intersections (note: these bulb-outs should be designed so as not to impede bicycle traffic). Raised sidewalks across intersections can improve safety and use. Provide "push buttons" for pedestrians to actuate traffic signals. Review traffic signal timing to ensure that all pedestrians can safely cross, including consideration of areas with a high concentrations of children or seniors.

- **Incorporate pedestrian plan requirements into specific plans and zoning, building, and subdivision regulations.** In doing so, make sure standards and guidelines are flexible, while still providing access for the mobility-impaired. Overregulation can stifle innovative design. Consider using planned unit development zoning or overlay districts to require pedestrian amenities in specific areas.
- **Integrate pedestrian planning throughout the site plan review process.** Pedestrians should be considered from the start of the planning process. Based upon the master plan and design guidelines, develop a checklist to use in the review process. Distribute the checklist and design guidelines to developers before they submit plans. Consider pedestrians when designing intersections, interchanges, street widenings and new streets.
- **Require developers to include pedestrian facilities and amenities.** Require developers to install facilities (particularly sidewalks) and certain amenities (such as landscaping) or pay a fee for installation. Density bonuses or other incentives could be offered to developers installing more than the minimum facilities and amenities.
- **Require Environmental Impact Reports (EIRs) to analyze impacts on pedestrians.** EIRs for roadway projects should include pedestrian impact analysis and mitigation measures.
- **Identify and correct special problem areas.** Keep adequate records of pedestrian accidents to pinpoint problem areas. Conduct special studies in these areas and implement solutions.
- **Maintain pedestrian facilities.** First, design durable and easy-to-maintain pedestrian facilities. Next, establish a regular inspection and maintenance schedule. Provide other departments and utilities with forms to notify the Public Works Department of problems, such as cracked sidewalks. Revise street standards to allow or require narrower streets by reducing the minimum and/or maximum widths, reducing lane widths, or enlarging sidewalks.
- **Reduce standards for curb radii.** This will lower speeds of turning cars and reduce the amount of time needed for pedestrians to cross the street. The Federal Highway Administration recommends turning radii of 15-25 feet for arterial streets with substantial turning volumes of buses or trucks. Smaller radii are appropriate for local street intersections. Older cities in Europe and parts of the Northeast often have curb radii of three to five feet without significant costs to mobility.[4] On streets with bus service, small curb radii may not be feasible. Coordinate policies with transit providers and emergency service providers.

Transportation Benefits

Many communities have sizeable demand for nonmotorized travel but lack suitable pedestrian facilities and resources to accommodate their wishes. A 2003 survey by the Surface Transportation Policy Project revealed that 38 percent of respondents would like to walk to work and 80 percent would like to walk for exercise.[5] Nationwide, nine percent of vehicle trips to work and 19 percent of nonwork vehicle trips are less than one mile.[6] If just 10 percent of these short trips were made on foot instead of driving, total vehicle trips would be reduced by nearly three percent.[7]

One study found that residents in communities with pedestrian-friendly streets are three times more likely to walk to their destinations compared with residents in otherwise comparable communities without pedestrian facility and traffic calming improvements.[8] Another study found that when residents in a pedestrian-friendly community were compared to a comparable vehicle-oriented community, the pedestrian-friendly residents walked, bicycled, and rode transit 19 percentage points more for work trips and 11 percentage points more for nonwork trips.[9]

Energy and Environmental Benefits

Perhaps the best way to reduce automobile emissions is to reduce the number of cold starts. Almost 95 percent of the emissions from a one half mile trip come from starting and turning off the engine, if the engine is cold when started. Therefore, while trips under one half mile make up less than one percent of the total vehicle miles traveled (VMT), they can make up about six percent of the total emissions from household travel. Reducing these trips by 20-40 percent would reduce emissions by about 1-2 percent. Reductions in overall household gasoline consumption, which is more closely tied to travel distance, would probably be closer to one percent.

To the extent that the narrow streets and smaller curb radii encourage more people to walk, pollution from cars also will be reduced. Narrower street widths result in less storm water runoff due to the reduction in impervious surfaces.

Economics

Providing additional or improved pedestrian facilities in a new development will increase costs to the developer. However, when integrated into site plans from the outset, pedestrian facilities can add to the marketability of the development. In several case studies, improving walking conditions in a community raised property values and retail sales significantly.[10] The costs of installing pedestrian facilities (sidewalks, crossing signals, etc.) and amenities (benches, landscaping, etc.) in existing areas will vary.

Below is a table indicating the average cost of implementing common pedestrian improvements and traffic calming measures:

» Speed humps: $1,000 each

» Raised Crosswalks: $2,000-$15,000

» Curb extensions: $2,000-$20,000 per corner

» Mini-circles: $6,000-$12,000

» Pedestrian Signals: $20,000-$40,000

» Raised Intersections: $25,000-$75,000

» Grade-separated crossings: $500,000-$4 million[11]

Some households can operate with only one car instead of two, if access for walking, bicycling and transit is adequate. For new cars, savings could range from $4,200 to $6,900 per year in ownership costs (insurance, finance charges, license, etc.) and 36 to 91 cents per mile in operating costs.[12]

Funding Sources

Several sources of funding should be considered for pedestrian facilities and amenities in new and existing development, including:

» Capital Improvement Program.

» Community Development Block Grants.

» Development impact fees.

» Special assessment districts.

» Donations from citizens or organizations.

» Federal funding: Federal sources of funds for pedestrian facilities include the Transportation Enhancements Program, the Safe Routes to Schools Program, and many Federal highway programs. See the Federal Highway Administration Web Site, "Funding Sources for Pedestrians and Bicyclists," for more detail; http://www.fhwa.dot.gov/environment/bikeped/bp-broch.htm#funding.

» State of California funds. For a full list, see "Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers" in the resource section below.

Programs in Operation

The City of **Sacramento** adopted a set of Traffic Calming Guidelines that offer a toolbox of traffic calming measures, outlines standard designs, and define processes for retrofitting neighborhoods. When a neighborhood is identified for inclusion in the traffic management program, a local Traffic Calming Committee is established that coordinates regularly with the Department of Public Works to select and plan for appropriate traffic calming improvements. As a result, average speeds have been reduced in local neighborhoods, and new neighborhoods are now designed from the start to lower vehicle speeds.[13] Sacramento has also developed a Pedestrian Master Plan, on-line at: http://www.sacdot.com/projects/ADA%20and%20Pedestrian%20Projects/Pedestrian_Plan.

The City of **Oakland** applied analytical methods to identify locations with a high pedestrian demand and a low supply of facilities, based on locations of population and employment, trip generators, and pedestrian facilities. The maps also showed locations of pedestrian/vehicle collisions. The city solicited community input to identify areas avoided by pedestrians. Results were used by the city to develop the Oakland Pedestrian Master Plan, adopted in 2002. http://www.oaklandnet.com/government/Pedestrian/index.html

In 1999, the City of **El Cajon** passed a new implementation plan to revitalize downtown. The plan reduced East Main Street from four lanes and on-street parking to two lanes and angled parking. Sidewalks were expanded to make walking more accessible and to create public space for outdoor dining, landscaping, and curb extensions at intersections. The city also adopted a land use plan favoring mixed-use and higher-density developments downtown, and enhanced nearby walkways to connect to East Main Street. Since 2001, 179 new businesses opened and 746 new jobs were created. Since 2002, 91 percent more customers shop and dine downtown.[14]

The City of **Bellevue, Washington**, has taken steps toward a more walkable downtown by adopting specific design guidelines and incentives. Under the land use code, new development and substantial remodeling projects in the central business district must provide a minimum amount of amenities. In most cases, developers can increase the floor area ratio and building height by providing additional amenities, such as plazas, awnings and arcades for weather protection, public restrooms, pedestrian-oriented retail services on street frontages. Developers who contribute to the city's "Major Pedestrian Corridor," a corridor limited to foot traffic with a transit center at one end, receive large bonuses.

The city developed design guidelines to supplement criteria in the land-use code. For example, along many central business district corridors, developments must include windows with visual access, multiple entrances, canopies, awnings or arcades, walls that abut the sidewalks (to define and enclose the street corridor) and different architectural features or materials at the ground or lower levels. Applicants must submit a conceptual master plan that indicates how the guidelines will be met. http://www.bellevuewa.gov/development-services.htm

Resources

Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers (Alta Planning and Design, 2005) is a resource prepared for the California Department of Transportation (Caltrans) that identifies standards and innovative practices for pedestrian facilities. Included are suggested practices for crossings, signals, sidewalks, and a variety of traffic calming measures. Available on-line: http://www.dot.ca.gov/hq/traffops/survey/pedestrian/TR_MAY0405.pdf

The *Pedestrian Facilities Users Guide* (Zegeer, et al., 2002) is a resource prepared for the Federal Highway Administration provides useful information on walkable environments and engineering improvements for pedestrians. http://drusilla.hsrc.unc.edu/cms/downloads/PedFacility_UserGuide2002.pdf

The Pedestrian and Bicycle Information Center (PBIC) web site, funded by the U.S. Department of Transportation and operated by the University of North Carolina Highway Safety Research Center, offers examples of model pedestrian facilities, suggested engineering specifications, case studies and frequently asked questions for transportation professionals. http://www.walkinginfo.org

Design and Safety of Pedestrian Facilities (Zegeer, et al., 1998) is a recommended practice guide provided by the Institute of Transportation Engineers. Included are suggested guidelines and design considerations for improving pedestrian mobility and implementing traffic calming measures. http://safety.fhwa.dot.gov/ped_bike/docs/designsafety.pdf

U.S. Department of Transportation, Bicycle and Pedestrian Program, (202) 366-8044. http://www.fhwa.dot.gov/environment/bikeped

Related Strategies

- L.1.2 Land Use Diversity
- L.1.3 Transit-Oriented Development
- L.1.4 Design Sites for Pedestrians and Transit Access
- L.3.1 Complete Streets and Street Design
- L.3.2 Street Trees
- L.4.1 Bikeways

Endnotes

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CALIFORNIA AND FEDERAL CLEAN AIR ACTS

In 1988, California's state legislature passed the California Clean Air Act. Two years later, Congress amended the Federal Clean Air Act. Both laws have major implications for local government planning.

What Does the California Clean Air Act Require?

The California Clean Air Act (CCAA) requires air quality plans to be prepared for areas of the state that do not meet air quality standards for volatile organic compounds, nitrogen oxide (NOx), carbon monoxide, or sulfur oxide (SOx) (these areas are referred to as non-attainment areas since they do not attain air quality standards). The original plans were due in July 1991 and were to be designed to achieve a five percent annual reduction in emissions. There also are state standards for particulate matter, sulfates, hydrogen sulfide, vinyl chloride, and visibility.[1]

The CCAA requires each plan to include a wide range of measures. Each nonattainment area is classified as moderate, serious, or severe for each category of pollutant according to the severity of the problem. Plans for serious areas must include transportation control measures (TCMs) that substantially reduce the rate of increase in vehicle trips and miles traveled. Plans for severe areas must include TCMs which will achieve an average occupancy of 1.5 passengers per vehicle during weekday commute hours with no net increase in vehicle emissions after 1997. Any ozone nonattainment area that cannot demonstrate that it will achieve a five percent annual reduction in NOx or volatile organic compounds must include provisions for the adoption of "all feasible" emission control measures.

Who Implements the California Clean Air Act?

The responsibility for developing, adopting, and implementing air quality plans under the CCAA belongs to air pollution control districts or air quality management districts (air districts). Often, these districts cover a single county or a portion of one. In most of these areas, the county board of supervisors serves as the air district governing board. In other instances, the air district covers more than one county and the board includes representatives from several jurisdictions. The metropolitan planning organization or council of governments can also work with the air district to develop the TCMs and other aspects of the air quality plan.

Air districts are also responsible for reducing emissions from most fixed "stationary sources" ranging from industrial and commercial facilities to furnace usage at residences. The California Air Resources Board (ARB) is responsible for reviewing and approving the air quality plans for these reductions and publishing guidance on implementing provisions of the CCAA, including TCMs and indirect source control measures. In addition, the ARB is responsible for reducing direct emissions from mobile sources including cars, trucks, and most off-road equipment. (Interstate trains, planes, and large ships, are under federal or international jurisdiction.) ARB also adopts emission limits for consumer products such as household cleaners and personal grooming products, and routinely develops state plans that identify the strategies the state will rely upon to reduce emissions from these sources. Area-specific emission reductions from these state strategies are provided to the local air districts for use in composing their CCAA or federal air quality plan.

Cities and counties in California are not directly responsible for implementation of the California or Federal Clean Air Acts, but can play a key role in the development, update, and implementation of local air quality plans, under both the federal and state acts. Some TCMs are best implemented by cities or counties. In these cases, TCMs adopted by an air district will not be effective without supportive city and county policies, including land use planning to facilitate alternative modes of transportation.

Under CCAA, an air district may delegate implementation of TCMs and/or indirect source measures to any local agency, including cities and counties, if three criteria are met:

1. The local agency submits an implementation plan that provides for adequate resources to adopt and enforce the measure(s).
2. The local agency measure(s) are at least as stringent as those in the district plan.
3. The district adopts procedures to review the performance of the local agency.

SB 375 and Air Pollution

SB 375, the Sustainable Communities and Climate Protection Act of 2008, provides another mechanism for local governments to address air pollution concerns. It requires regional governments to develop a "Sustainable Communities Strategy"(SCS) that demonstrates how local land use changes and other strategies can achieve regional targets for greenhouse gas reductions from transportation sources. Local governments play a key role in implementing land use changes in the SCS, where reductions in travel-related emissions can bring both air quality improvement and a reduction in greenhouse gases. See Section III of this guide for more information.

How do the California and Federal Clean Air Acts Compare?

» Similar to the CCAA, the Federal Clean Air Act requires plans (State Implementation Plans or SIPs) for areas that violate federal air quality standards. Federal standards are less stringent than California standards for some pollutants, including ozone (the pollutant used to measure the severity of "smog").

» If approved by the U.S. Environmental Protection Agency (U.S. EPA), each air quality plan prepared for an air district becomes the SIP for the region. The SIPs, or specific portions of the SIPs, are due at various times, generally three to five years after the U.S. EPA promulgates a new standard.

» The Federal Act requires plans for the control of particulate matter, as well as ozone, carbon monoxide, NOx, and SOx – the "criteria" pollutants.

» The Federal Act outlines different classifications for the air pollution problem: marginal, moderate, serious, severe, and extreme for each pollutant. But, like the CCAA, requirements become more stringent and numerous the higher the level of pollution.

» The Federal Act requires that plans demonstrate attainment of the standards by a certain date (depending upon the classification), in addition to the periodic percentage emission reductions required by the CCAA.

» The Federal Act requires the imposition of sanctions if a state fails to submit an adequate SIP. Sanctions may include reduced federal highway funding and/or a requirement that new stationary sources purchase additional waivers to offset emissions.

» The Federal Act places primary responsibility for developing plans on the states, though some states, including California, pass much of this responsibility on to local air districts.

» Under the Federal Act, SIPs for areas classified as severe for ozone and serious for carbon monoxide must include TCMs to offset any growth in emissions from an increase in vehicle trips or miles traveled. These must require employers to submit plans designed to increase the average vehicle occupancy during peak periods.

» The Federal Act requires all federal actions, including highway funding and approvals, to conform with the area's SIP.

» The U.S. EPA is responsible for overall implementation of the Federal Act.

How do the California and Federal Clean Air Acts Relate to the General Plan?

In some areas, the air district may ask local governments to adopt air quality elements or air quality policies into other elements of their general plans to support the regional air quality plan. This may be a prerequisite for delegation of the district's indirect source rule to the local government. By adopting strong general plan policies and programs to improve air quality, local governments may reduce or eliminate the need for air districts to regulate indirect sources.

How do the Clean Air Act Requirements Relate to the Energy Aware Planning Guide?

Many of the policies included in the Guide could be used by cities and counties to help implement a regional air quality plan and meet transportation conformity requirements. Transportation and land use measures can directly reduce emissions from vehicle use. The efficiency measures in the other sections – buildings, solid waste, and water use – will reduce emissions indirectly by reducing energy consumption and cutting emissions from power plants and the combustion of natural gas.

Cities and counties should consult with their local air district when adopting these policies. Local policies should be consistent with and complement the air quality plan for the region. The air district may have technical and/or financial assistance available for implementation. In addition, to receive credit from ARB or the U.S. EPA for emissions reductions resulting from measures in their plans, the air district must meet certain requirements and standards. If a city or county is implementing the measure, it should work with the air district to assure that such requirements are met.

For a directory of California's Local Air Districts, see http://www.arb.ca.gov/capcoa/roster.htm.

For additional information on CCAA and the Federal Clean Air Act, see http://www.arb.ca.gov/html/lawsregs.htm.

Endnotes

1. California Health & Safety Code, Div. 26 – Air Resources.

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CONGESTION MANAGEMENT PROGRAMS

In 1990, California legislators passed Congestion Management legislation (AB 471) in response to worsening traffic congestion. The legislation put in place a process for managing congestion in all urbanized counties in the state. It also increased funding for transportation and established a process for prioritizing transportation projects based on their likelihood of relieving congestion.

The process for managing congestion is referred to as a Congestion Management Program (CMP). The legislation requires CMPs to be developed, adopted, and updated biennially for every county that includes an urbanized area (over 50,000 population). CMPs are developed by the Congestion Management Agency (CMA). The CMA can either be the county transportation commission or another public agency designated by the county board of supervisors and a majority of the city councils representing a majority of the population in incorporated areas.

What is a Congestion Management Program?

A Congestion Management Program is a program to address congestion problems in an integrated manner on a countywide basis. It must include five elements:

1. Traffic **level of service** standards that are established for a system of highways and roadways designated by the agency.

2. A **performance element** that includes metrics to evaluate current and future multimodal system performance for the movement of people and goods. These metrics must cover the areas of highway, road, and transit system performance.

Congestion Management Agencies are the institutions charged with developing the Congestion Management Program. Typically, the county transportation authority serves as the CMA. Examples of large Congestion Management Agencies in California include:

» San Francisco County Transportation Authority

» Santa Clara Valley Transportation Authority

» Alameda County Congestion Management Agency

» Riverside County Transportation Commission

» Los Angeles County Metropolitan Transportation Authority

3. A **travel demand element** that promotes alternative transportation methods, including, but not limited to, carpools, vanpools, transit, bicycles, and park-and-ride lots; improvements in the balance between jobs and housing; and other strategies.

4. An analysis of the **impacts of land use decisions**

made by local jurisdictions on regional transportation systems, including an estimate of the costs associated with mitigating those impacts.

5. A **seven-year capital improvement program** to determine effective projects that maintain or improve the performance of the multimodal system for the movement of people and goods, and to mitigate regional transportation impacts.

"…A congestion management program shall be developed, adopted, and updated biennially consistent with the schedule for adopting and updating the regional transportation improvement program, for every county that includes an urbanized area, and shall include every city and the county…"

CMP Legislation
As Amended In Assembly Bills 1963 & 2419

What is Level of Service (LOS)?

Level of service (LOS) is a commonly used standard for describing traffic conditions. LOS A represents the best operating conditions and LOS F the worst. The Congestion Management Program legislation requires that roadways be maintained at a certain LOS standard. If a roadway segment or intersection on the CMP system falls below the standard, local governments in which the deficiency occurs need to investigate the cause, and if certain conditions are met, must develop a deficiency plan to remedy the problem. The deficiency plan must include a list of improvements necessary to maintain the minimum LOS standard for the deficient road segment or intersection and estimated costs.

The LOS standard and the requirements for the deficiency plan have evolved over time as California adopts a multimodal approach to congestion management. In the past, the LOS standard was set at "E," and a deficiency plan was triggered if this threshold was not met. Deficiency plans were focused on addressing congestion through roadway improvements, such as roadway widenings to increase vehicle throughput). The purpose was to ensure that roadway congestion be reduced in all types of environments.

The current legislation is more flexible, recognizing both that maintaining roadway level of service standards is not always desirable or possible, especially in urban infill environments, and that a broad range of strategies beyond roadway capacity expansions can be used to address congestion and associated air quality impacts. The legislation achieves this by exempting designated "infill opportunity zones" from the LOS E standard and by providing more flexible strategies for addressing air quality and congestion issues.

Infill opportunity zones are defined as areas designated for new compact residential or mixed use developments near transit (rail, ferry, bus). These transit-oriented environments typically have relatively high levels of walking, bicycling, and transit use, resulting in regional air quality and greenhouse gas reduction benefits. Efforts to improve level of service for vehicles in these environments can undermine those benefits by reducing space and resources available for alternative modes of travel.

The legislation provides that within these designated urban infill areas, cities, and counties may do either of the following as an alternative to applying the LOS E standard:

1. Use a multimodal or areawide level of service standard (see sidebar for explanation).

Level of Service is a metric used to indicate traffic conditions. LOS A represents the best conditions (freeflow), while LOS F represents the worst traffic conditions.

2. Approve a list of flexible level of service mitigation options including transit infrastructure, ridesharing, vanpools, and other investments in alternative modes.

Even outside of designated infill zones, local jurisdictions may include a range of strategies for addressing LOS deficiencies. They can include strategies in the deficiency plan such as improved public transit service and facilities, improved nonmotorized transportation facilities, high occupancy vehicle facilities, parking cash-out programs, and transportation control measures, so long as they contribute to significant improvements in air quality.

How Are Local Governments Involved?

» Cities and counties must designate the Congestion Management Agency.

» Local governments must be consulted during the Congestion Management Program development process.

» Local governments may need to provide transportation and land use data for the development of the CMP and related models.

» Cities and counties develop and implement deficiency plans for segments or intersections of the CMP system in their jurisdiction which do not meet the LOS standards.

» Cities and counties must implement the land use analysis program to assess the impacts of land use decisions on the regional transportation system.

» Local governments may identify projects for inclusion in the Capital Improvement Program.

» Cities and counties are not required to adopt or approve the CMP; it is approved by the CMA at a public hearing.

» Local governments frequently need to provide monitoring data to the CMA.

Multimodal and Areawide LOS Standards

» **Roadway** LOS is the traditional performance standard required by the CMP legislation. It is a measure of traffic conditions at specific road segments and intersection. If road LOS falls below a certain standard, then a deficiency has occurred.

» **Areawide** LOS standards are an aggregate of roadway LOS conditions across a broad area instead of a specific intersection or roadway segment. Averaging areawide LOS in this way can reduce the chance of a deficiency occurring.

» **Multimodal** LOS standards take into account conditions for several modes (e.g. transit, walking, bicycling).

Relationship Between the CMP and Other Planning Processes

» **Regional Transportation Plan:** The regional transportation plan must be consistent with the capital improvement program contained in the Congestion Management Program

» **Regional Transportation Improvement Program:** For certain transportation projects to be included in the Regional Transportation Improvement Program, they must a part of in the capital improvement program of the Congestion Management Program. The Congestion Management Programs are therefore a main source from which the Regional Transportation Improvement program of projects is derived..

» **General Plan:** The law does not require that the CMP be incorporated into general plans.

How is the CMP Implemented and Enforced?

Each year, the Congestion Management Agency is required to determine whether cities and counties are conforming to the Congestion Management Program, including the LOS standards and the land use analysis program. If the Congestion Management Agency determines that a local government is not conforming, and the local government does not take corrective action, the State Controller must withhold certain funds from the city or county (those required to be apportioned by Section 2105 of the Streets and Highways Code). If, within 12 months, the city or county is still not conforming, the withheld funds are given to the Congestion Management Agency for use on projects of regional significance included in the capital improvement program or in a deficiency plan adopted by the agency.

Resources

The Congestion Management Program statutory requirements appear in the California Government Code, Sections 65088 through 65089.10. They may be accessed on-line at: http://law.justia.com/california/codes/gov/65088-65089.10.html.

Many of California's Congestion Management Agencies publish information and background on CMP legislation, public agency requirements, and other details. For example, see the Congestion Management Program web site of the San Francisco County Transportation Authority: http://www.sfcta.org/content/view/301/147.

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TRANSIT FARE MEASURES AND DISCOUNTS

By encouraging residents and workers to use mass transit instead of driving, local governments can help reduce the energy use and greenhouse gas emissions associated with transportation, as well as the maintenance and construction costs of road upkeep and widening. One method of encouraging use of mass transit is to reduce its cost, since the comparative cost of travel is a key component of a traveler's transportation mode choice.[1] However, measures to reduce fares will be most effective in conjunction with service improvements, because travelers are most responsive to the travel time and reliability of services they use.

Transit incentives may include permanent cash fare reductions as well as targeted bulk pass discounts through employers and residential organizations. Local or regional transportation demand management (TDM) programs can also be a means for distributing fare discounts. Establishing a tiered price structure whereby off-peak fares are lower than peak-hour fares can encourage off-peak travel while maintaining significant farebox revenues during peak hours.

The most challenging element of fare reduction measures is assuring that they do not unduly impact the finances of transit agencies. Transit agencies throughout the United States rely on funding subsidies and must make up any shortfall in fares. Some fare measures may attract sufficient new ridership that they pay for themselves, but often this is not the case. In other cases, such as employee pass programs, it may be possible to structure a bulk payment that

The Los Angeles DASH bus network charges 25¢ per ride. Photo: Los Angeles Department of Transportation.

compensates for lost fare revenue. Some transit agencies have surplus capacity (i.e., empty seats), particularly during midday periods, that can be used at relatively low cost.

While some cities operate their own local transit agencies, these entities are most often separate. Cities, other levels of government, and transit agencies will have to work together to identify funding sources that allow fare reductions.

General Plan Language Ideas

» The City/County shall work with the transit service provider to identify and obtain sources of funds for fare reduction programs.

» The City/County shall coordinate with the transit service provider to establish a fare discount program for municipal employees in order to encourage transit ridership. If successful, the program may be expanded to other area employers and neighborhood organizations.

» The City/County shall work with major employers to encourage them to offer discounted or pre-tax transit passes to their employees.

Implementation Ideas

» **Provide discounted fares during off-peak hours.** Off-peak travel is more sensitive to transit fare fluctuations than peak-hour travel. Consider providing a tiered pricing structure that discounts off-peak trips made during midday and evening travel to encourage new ridership while maintaining peak-hour farebox revenues.

» **Offer multiple fare purchase options.** Giving users a chance to purchase multiple or monthly pass options at a slight discount can be effective in increasing ridership, depending on the overall fare structure and transit system characteristics.

» **Provide discount pass options for students and seniors.** Providing students and seniors with discount passes can encourage transit use, typically in off-peak hours. Offering discount transit passes for seniors is required by law.

» **Provide "deep discount" transit passes.** Allow larger employers or neighborhood organizations to purchase bulk monthly or annual transit passes at 20 to 30 percent discount, to provide to employees at reduced price. Deep discount passes are particularly effective at reducing ridership loss associated with a systemwide rate hike.[2]

» **Consider free or discount fare zones in downtown business districts.** Research has shown that free or discounted fare zones or shuttles in downtown business districts can be successful in increasing transit ridership, particularly for midday/lunchtime travel.[3]

» **Consider unlimited transit pass partnerships for target areas.** Unlimited transit passes are distributed free to employees at participating sites. For instance, the Denver Regional Transportation District offers its "Eco Pass" to areas targeted for transit ridership growth. The Eco Pass provides eligible travelers with unlimited transit and a guaranteed ride home.[4]

» **Consider providing discount transit passes to residents of transit oriented developments.** Consider offering developers of transit oriented developments the opportunity to offer free or reduced transit passes to residents in exchange for reducing parking requirements. This can help improve the attractiveness of transit compared with driving for residents.

» **Develop consolidated fares and fare media for trips using more than one transit agency.** Many transit trips, especially in larger urban areas, require use of more than one transit agency. These trips can be facilitated with unified fare media (e.g., "smart cards" good on more than one transit system) and with single fares for multiagency trips, rather than requiring the passenger to pay two fares.

Transportation Benefits

Several studies have attempted to estimate the expected ridership response to a decrease in transit fares. In general, ridership is more sensitive to fare changes in:

» Smaller cities;

» More dispersed cities; and

» Off-peak hours.[5]

One study found that a 10 percent drop in bus fare can be expected to increase ridership by an average of 3.6 percent in cities of over one million residents, and by 4.3 percent in cities of less than one million residents. The average increase in off-peak ridership following a 10 percent fare decrease was estimated at 4.2 percent, while peak-hour ridership increased only 2.3 percent.[6]

Bus ridership tends to be more sensitive to fare changes than rail ridership. A 2004 study estimated that a 10 percent bus fare reduction results in a four percent ridership increase, whereas a 10 percent light rail transit fare reduction results in a three percent ridership increase.[7] Other research indicates that ridership on heavy rail systems rises roughly 1.7 percent for every 10 percent price reduction.[8]

Many transportation demand management (TDM) programs involve issuing transit fare discounts in order to reduce vehicle miles traveled (VMT) (see strategy T.2.1 Transportation Demand Management Programs). TDM programs that offer subsidized transit fares have proven to be effective at increasing ridership and reducing vehicle-trips.[9] One landmark study of worksite TDM initiatives found that programs that focused on support/promotion/information had very little impact on travel, whereas programs that focused on financial incentives and disincentives (including transit subsidies) realized a 16 percent vehicle trip reduction.[10]

Increases in regional employment, central city population, or total transit service miles will enhance ridership growth in response to fare reductions.[11]

Energy Savings and Environmental Benefits

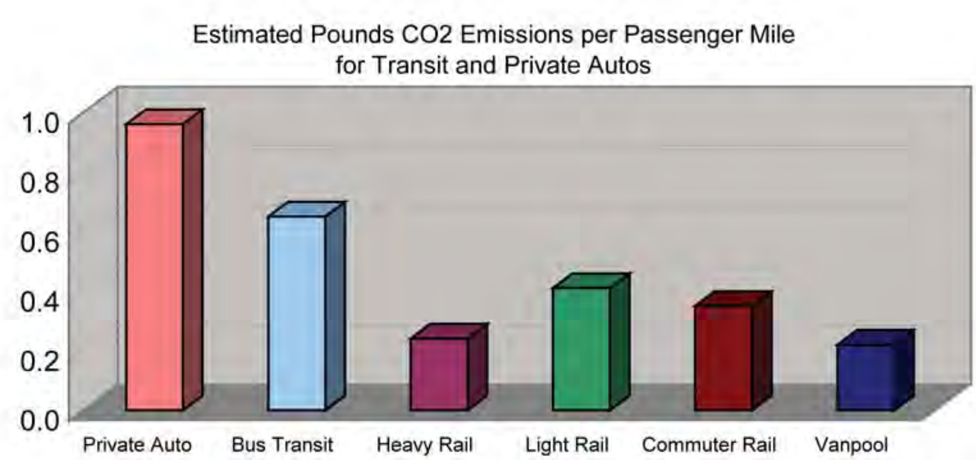
The energy and environmental impacts of transit fare reductions vary based on how many new riders are attracted to transit, how many of those riders previously drove, the length of their trips, and other factors. Measures that can draw the most travelers away from single occupant vehicles will result in the greatest emissions reductions. Below is a comparison of estimated emissions per passenger mile provided by the Federal Transit Administration, based on average transit vehicle occupancies versus a single-occupancy vehicle.[12] To achieve the greatest environmental benefits, fare reductions should be applied at times or locations where excess capacity exists (such as off-peak hours), since no new transit service needs to be added to meet demand.

One study found that a 10 percent drop in bus fare can be expected to increase ridership by an average of 3.6 percent in cities of over one million residents, and by 4.3 percent in cities of less than one million residents. The average increase in off-peak ridership following a 10 percent fare decrease was estimated at 4.2 percent, while peak hour ridership increased only 2.3 percent.

To the extent that fare reductions and discounts attract travelers from ridesharing or nonmotorized modes to transit service, the environmental benefits of fare reductions can be limited. While fare reductions may not always provide significant energy savings and emissions reductions alone, they provide additional accessibility that may be critical to making other components of a larger energy reduction or TDM strategy. Any policy that makes automobile use less attractive needs to be counterbalanced by other options that make available and enhance travel alternatives.[13]

Economics

A transit fare discount program's impact on revenues will vary based on the type of discount, the frequency of its use, and the number of existing riders versus new



riders who benefit from the discount. Discount pass options such as monthly or multiple-ride passes are generally used by frequent transit users rather than occasional users, which typically results in revenue losses for the transit agency.[14] However, revenue gains may be achieved when such passes are introduced with a simultaneous overall cash fare increase. When Atlanta introduced a monthly discount pass alongside a 67 percent cash fare increase, it reported a 36 percent revenue increase from those who became monthly pass users.[15]

The introduction of an unlimited ride pass for the first time almost always results in a revenue loss unless accompanied by an overall fare increase. However, unlimited ride passes and fare prepayment discounts have been shown to increase ridership and revenue in large, complex transit systems.[16]

Programs in Operation

The **Los Angeles Department of Transportation** (LA DOT) operates the DASH bus network, which consists of over 35 routes that connect downtown Los Angeles with surrounding areas. DASH provides frequent localized service around the downtown area and serves as a feeder network to the larger Los Angeles Metropolitan Transportation Authority (LA Metro) transit system. Established in 1976, DASH fares have remained 25 cents systemwide. Seniors may ride for 10 cents, and monthly passes are available for $9. The low fares are supported by a subsidy from LA Metro, which paid $760,000 to offset the discount fares in 2006. The system's low fares have resulted in a steady increase in ridership. From 1999 to 2004, DASH ridership improved 35 percent while the national transit ridership average rose by only 15 percent.[17] LA DOT has reported DASH ridership at nearly 30 million trips annually.[18]

The **Santa Clara Valley Transportation Authority** (VTA) offers an annual "ECO Pass" for businesses and residential associations. Employers may purchase the annual pass for their full-time employees at a deep discount. Residential groups such as condominiums, apartments, homeowner associations and community associations can purchase the ECO Pass as well. Passes must be purchased for all full-time employees or residents. Prices are scaled based on organization size and proximity to VTA service, with larger organizations and those farther from downtown receiving lower rates. The minimum ECO Pass contract is $1,495. Passes can be used systemwide on any of VTA's bus or light rail lines. More information on VTA's ECO Pass program is available at http://www.vta.org/news/factsheets/vta_information/04_eco_pass_program_031204.pdf

The **University of California at Berkeley** (UCB) has partnered with Alameda-Contra Costa Transit District (AC Transit) to allow full-time students unlimited rides on the AC Transit system. Prior to the program's inception in 1997, roughly 5.6 percent of UCB students used AC Transit before the program's implementation. By 2000, 14.1 percent of UCB students used AC Transit. During this period, AC Transit's fare revenue increased from $84,500 per month in 1997 to $125,100 per month in 2000.[19]

The **Metropolitan Transportation Commission** and **AC Transit** recently initiated a pilot program to provide free electronic transit cards to residents of transit oriented developments for periods of between six months and one year.

Resources

Transit Cooperative Research Program (TCRP) Report 95 – Traveler Response to Transportation System Changes, Chapter 12: Transit Pricing and Fees (Transportation Research Board, 2004) examines traveler response to changes in the scheduling and frequency of transit service. http://trb.org/publications/tcrp/tcrp_rpt_95c9.pdf

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Related Strategies

T.1.2 Increased Transit Service and Improved Travel Time

T.2.1 Transportation Demand Management Programs

T.2.2 Transportation Management Associations

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INCREASED TRANSIT SERVICE AND IMPROVED TRAVEL TIME

Increasing service frequency, reducing travel time, improving reliability, and modifying schedules to match service with demand are some of the most common ways to boost transit service effectiveness. While new routes are required in some instances, more often better service on existing routes will be more effective in attracting passengers. These enhancements improve the experience of passengers and make using transit more desirable when compared to solo driving. In addition to increased frequency, lowering wait times and transfers and providing customers with real-time information are service improvements that can help increase transit ridership and reduce energy consumption. Scheduling affects the waiting time customers encounter and perceive when making a transit trip. Positive benefits to passengers may include reducing wait time at the start of a trip, or during transfers if required. Scheduling changes and providing real-time information on transit arrivals can also improve passenger comprehension and allow for easier planning, which has the effect of reducing perceived wait times.

This section will outline some of the numerous ways to improve transit service and travel time, including transit system design, route planning, scheduling, roadway design, and transit information. All of these elements can affect the speed, reliability, and ease of use of a transit system.

This AC Transit stop in Berkeley provides real time transit information to passengers.

GENERAL PLAN LANGUAGE IDEAS

» The City/County will identify a network of streets and roads where transit operates and where the City/County would like transit to operate. These transit streets will be planned and designed to support fast, reliable transit, along with pedestrians, bicycles, and other motor vehicles.

» Roadway design and signal operations and traffic calming practices in the City/County shall consider the impacts on transit service and ways to improve the speed and reliability of transit. Specific issues that will be routinely examined for bus routes include the design and location of bus stops, signal progression along corridors, and possibilities for bus-only lanes, queue-jumper lanes, bus bulbs and/or transit priority signals along major routes. The City/County transportation and public works departments shall coordinate with the transit service provider and other agencies as necessary to optimize roadway design and operations for transit.

Implementation Ideas

Transit System Design

» **Develop a comprehensive transit service network for the community.** Transit agencies should provide the most comprehensive network of transit lines feasible in their service area. Routes should serve major activity centers such as downtowns, medical centers, universities, and transportation hubs. Ideally, no resident would live more than one quarter mile from transit service, particularly in denser areas.

» **Balance the need for direct service with the need for easy transfers.** Transit passengers appreciate and use the fastest, most direct service possible. At the same time, it is important for transit agencies to establish a network of transfer locations, to allow easy transfers between lines. Potential transfer locations include downtown areas, rail or other fixed guideway stations, shopping centers, colleges and universities, and park-and-ride lots (see strategy T.1.3 Park-and-Ride Lots).

Roadway Design

» **Examine signal progression to speed bus operations along major corridors.** It may be possible to adjust signal progression to optimize transit vehicle movement, based on an analysis of stop locations and typical dwell times and travel times.

» **Consider bus-only lanes, queue-jumper lanes, and/or transit priority signals along major routes.** Queue-jumper lanes generally consist of a near-side right-turn lane and a far-side open bus stop, which allows buses to bypass traffic queued at congested intersections. Priority signals identify approaching buses and turn green, limiting delays caused by red signals.[1]

» **Design bus stops to minimize delays merging into traffic.** Placing "bulb-outs" instead of "pull-outs" reduces bus delays because the bus does not need to merge into traffic. Bulb-outs are most appropriate for lower-speed streets as their use on higher-speed streets may cause a safety hazard.[2]

» **Locate bus stops to minimize delays at intersection.** Experience has shown that far-side (past a traffic signal) bus stop locations (downstream of the intersection) are generally more efficient than near-side locations.[3]

Transit Scheduling

» **Establish fixed intervals on transit routes.** Establishing service at regular scheduled intervals is a convenience to passengers, who can plan in order to reduce time waiting for a transit vehicle. Setting standard intervals can create cost inefficiencies by requiring excessive layover and recovery time to keep intervals constant.[4] Slack time should be built into routes so that buses can generally arrive at stops on schedule, even if this means briefly holding buses at time points. This will ensure that arrivals are predictable and will allow customers to minimize wait time.

» **Schedule clock frequencies.** Trips scheduled to be at certain locations at regular intervals past the hour increase the convenience of passengers. For example, passengers would know the bus comes at :04, :14, :24 past the hour and so on, enabling them to limit time spent waiting at the bus stop.[5]

» **Consider "intertiming" trips that serve a common corridor.** Coordinate the timing when two or bus routes operate on a single street. This can result in better passenger service. Evenly spacing vehicles from different routes maintains constant headways, so that customers always know a vehicle will be approaching in X minutes. Even spacing also prevents "bunching," when one vehicle immediately follows another, causing the first vehicle to carry much heavier loads and make far more frequent stops. However, coordinating two lines on a street to maintain headways and prevent bunching is more complex than operating a single route.

Transit Route Planning

» **Schedule timed transfers where appropriate.** Transit passengers dislike transfers, and transit agencies should look for ways to reduce this burden. Studies have shown that riders prefer modest price increases and substantially longer journey times to transfers between transit vehicles. A 1993 study in Norway showed that passengers were willing to accept a 14-minute increase in travel time or pay over $.50 more to avoid a five-minute transfer.[6] Timed transfers are scheduled meets between two transit vehicles to facilitate immediate transfers from one line to another. Where service is frequent (every 15 minutes or less), ad hoc transfers are generally acceptable. Where service is infrequent (every 20 or more minutes), timed transfers are desirable.[7]

» **Consider "interlining" where appropriate.** Interlining is the practice of scheduling a bus to travel from one route to another through a common terminal during a service day. Optimal interlining can result in reduced costs and added convenience to the passenger. Combining two routes reduces redundant time spent traveling over the same loop, reduces mileage costs, and eliminates transfers for passengers transferring from one line to the other.[8]

» **Focus service on the busiest routes.** Some will be busier than others. Busier routes should have more frequent service, for more hours per day (on some routes, 24-hour-a-day service is appropriate). Well located frequent lines attract greater ridership. On very busy corridors, rail service may be appropriate. Some transit agencies, such as Portland's Tri-Met, have established a network of "Frequent Service" routes, which operate every 15 minutes or more frequently, seven days a week. Los Angeles Metro has a "12 Minute Map" identifying routes which operate every 12 minutes or more frequently on weekdays.

Transit Information

» **Provide transit information to transit users in a variety of ways.** Good information about transit is key to passengers' ability to understand and use the system. Increasingly passengers use transit agency web sites, which should have both bus schedules and trip planning services, similar to roadway direction services. Some prefer to get information by phone, while others prefer printed timetables. The bus sign (sometimes called a "flag") at the stop should list not only the bus routes stopping there, but destinations, and additional information if feasible. Additional information at the stop – posted timetables, transit system maps and area information – is also key.

» **Provide real-time information to transit users.** One of the newest forms of transit information is real-time information. Real-time information on the expected arrival times can be provided at major stops and stations via message signs, or at other locations through the use of wireless technology (cell phones and personal digital assistants). Services such as NextBus offer predictive algorithms that forecast the expected arrival time of the next bus. Real-time information also requires investment in on-board global positioning systems (GPS) equipment by the transit agency.

Transportation Benefits

When travelers choose whether to ride transit or take another form of transportation, reducing the "out of vehicle travel time" (waits and transfers) may be anywhere from twice to four times as important as reducing the travel time spent in a transit vehicle.[9]

According to several studies of traveler response to service improvements, a one percent increase in bus service frequency can generally be expected to result in a one-half percent improvement in ridership, while a 10 percent increase in bus service will generally attract a five percent increase in ridership.

In addition, limited information suggests that adding additional service hours (such as late evenings and early mornings) may be just as important as increasing frequency in peak hours.[10]

Still, many factors can affect ridership response to scheduling and service improvements. For instance, ridership is most responsive to frequency increases when prior service was infrequent (e.g., every 30 to 60 minutes), rather than frequent (e.g., every 10 to 15 minutes). High- and middle-income residential areas are more responsive to service increases than lower-income areas. Attempts to increase ridership in lower-income areas may be more responsive to fare discounts (see strategy T.1.1 Transit Fare Measures and Discounts). These factors may explain why increasing service frequency on commuter rail (which typically serves predominantly middle- and higher-income areas) tends to have a greater effect on ridership than increasing bus service frequency. Studies suggest that responses to frequency improvements in particular can be significantly affected by the state of the local economy. In general though, ridership tends to be more sensitive to frequency increases than to fare discounts.[11]

Off-peak travel is typically more responsive to service increases than peak-travel. Surveys suggest that the greatest concerns expressed by transit patrons are the dependability of service in general and the frequency of service in midday and evening hours.[12]

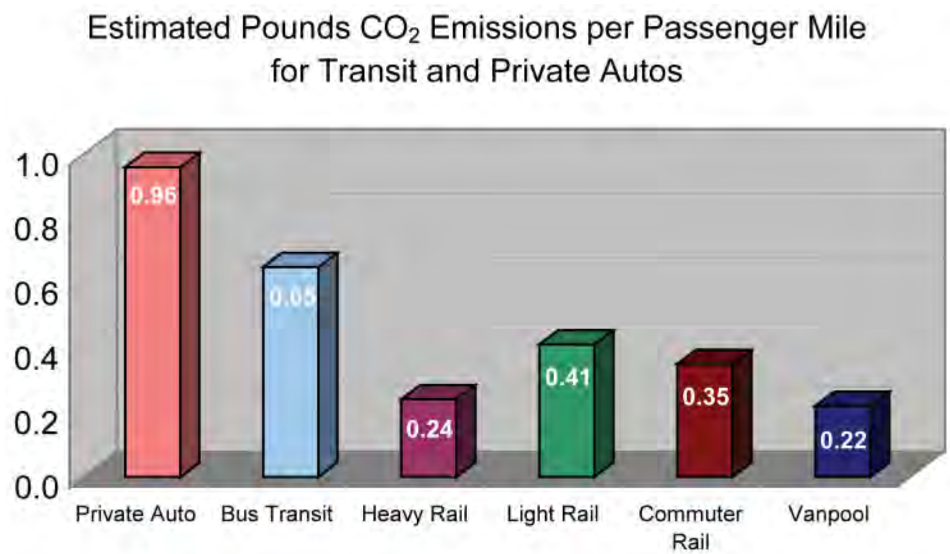
Energy Savings and Environmental Benefits

The energy and environment impacts of transit service improvements vary based on a number of factors, including land use, population density, parking availability and costs, and other corridor-specific variables. While increased bus service may reduce auto VMT and emissions, it also increases bus VMT and emissions. A 1982 model of a hypothetical bus corridor predicted that reducing transit headway from 30 to 15 minutes would result in significant reductions in carbon monoxide (CO) and hydrocarbon (HC) emissions, but increases in nitrous oxide (NOx) emissions (see below).[13]

According to several studies of traveler response to service improvements, a one percent increase in bus service frequency can generally be expected to result in a one-half percent improvement in ridership, while a 10 percent increase in bus service will generally attract a five percent increase in ridership (source: see endnote 10).

More recently, a 1998 study of 22 California fixed route transit and shuttle projects revealed that increased service along fixed route transit lines caused NOx emissions to increase slightly in some corridors, while all other emissions measurements decreased. Within transit projects, shuttles connecting transit stations to home or work and line haul transit projects provided the best emissions reduction results.[14] Public transportation produces greenhouse gas emissions at a lower rate per passenger mile than autos (see figure above); therefore, if increased service frequency attracts a significant number of new passengers, net reduction of carbon dioxide may result. Note however that if insufficient new passengers are attracted, the increased service frequency could result in a net increase in carbon dioxide emission. Additionally, the future balance of emissions impacts from transit service increases may change as transit and automobile emissions control technology evolves.

Hypothetical emissions impacts of increased transit service			Emissions (kg/hr)		
Transit Headway (minutes)	Car Trips	VMT	CO (Savings)	HC (Savings)	NO (Savings)
30	708	2,360	194	18.8	7.33
15	649	2,160	179 (15)	17.5 (1.3)	7.48 (-0.15)
5	622	2,070	177 (17)	17.5 (1.3)	10.0 (-2.67)



Source: U.S. DOT. 2009. *Public Transportation's Role in Responding to Climate Change*. Washington: Federal Transit Administration, U.S. Department of Transportation. Note: the "private auto" figure is for a single-occupancy vehicle.

While bus service enhancements may not always provide significant energy savings and emissions reductions alone, they provide additional accessibility and flexibility that may be critical to making other components of a larger energy reduction strategy work. Any policy that makes automobile use less attractive needs to be counterbalanced by other options that make available and enhance travel alternatives.[15]

Economics

Increasing transit frequency attracts more trips and increases farebox revenue, but rarely leads to a decreased net cost of transit operations. Due to the substantially higher operating costs associated with providing peak-hour transit service, increasing off-peak service to frequencies less than or equal to peak frequencies will always be less expensive than increasing peak frequencies.[16]

Programs in Operation

In March 1998, **Santa Monica's** Municipal Bus Lines increased its Lincoln Boulevard Route frequency from a 20 to a 10-minute headway between 6 a.m. and 6 p.m. The route runs between Los Angeles International Airport (LAX) and downtown Santa Monica. The frequency enhancements were combined with small route realignments and a new public advertising campaign identifying the route as a way to get from LAX to Santa Monica. In total, the enhancements produced a 23 percent increase in service, which resulted in a 19 percent increase in ridership.[17]

In October 1992, **Santa Clarita,** an outlying suburb north of the San Fernando Valley, obtained Metrolink commuter rail service to Los Angeles, and the Metrolink station became a common point for most local bus routes. Between fiscal years 1992 to 1993 (FY93) and 1997 to 1998 (FY98), Santa Clarita Transit ambitiously expanded service hours and increased frequencies. Prior to 1992, bus coverage was provided Monday – Saturday on hourly headways, and combined headways were 30 minutes on local arterial segments. Between FY93 and FY98, Saturday service hours were expanded by three hours; weekday service hours were expanded by two hours in 1992 and again in 1995 on three routes; Sunday service was introduced on two-thirds of local routes in 1996; 30-minute headways were introduced on four routes (including two on weekends); peak service was increased to approximately 15-minute headways on two routes and most of a third route; and operating speeds increased from 16 mph to 19 mph. These service enhancements were accompanied by 33 percent fare increases. Nevertheless, growth in local transit ridership grew by 120 percent from FY93 to FY98, outpacing local service increases.[18]

Resources

Transit Cooperative Research Program (TCRP) Report 95, Chapter 9: Transit Scheduling and Frequency – Traveler Response to Transportation System Changes (Transportation Research Board, 2004) examines traveler response to changes in the scheduling and frequency of transit service. http://trb.org/publications/tcrp/tcrp_rpt_95c9.pdf

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Designing With Transit: Making Transit Integral to East Bay Communities is a local manual for municipal governments on physical design issues related to transit service published by AC Transit. http://www.actransit.org/pdf/designing_with_transit.pdf?PHPSESSID=b5f00dc2d0bfa1c0bb7f1c089f1658a2.

Related Strategies

T.1.1	Transit Fare Measures and Discounts
T.2.1	Transportation Demand Management Programs
T.2.2	Transportation Management Associations

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PARK-AND-RIDE LOTS

Park-and-ride lots can range in size from multistory parking garages to small surface parking lots. Located at transit stations and bus stops, they enable individuals without nearby transit access to park and use transit for the remainder of their commute. Located near highway onramps on the urban fringe, these lots can also serve as "park-and-pool" pick-up points for carpools and vanpools to facilitate ridesharing (see strategy T.2.4 Ridesharing). Park-and-ride lots shift the parking burden of car commuters from urban centers to suburban and peripheral transit nodes. By encouraging mixed-mode travel, successful park-and-ride lots can significantly reduce vehicle miles traveled (VMT) and associated energy consumption. Since much of a car's emissions are released when the car is started ("a cold start"), park-and-ride lots tend to have a minimal effect on emissions reduction.

Implementing intelligent transportation systems that inform drivers about parking availability increases efficient use of high-demand park-and-ride lots and further reduces VMT. In higher-density urban locations, park-and-ride facilities may be in the form of small, scattered lots and/or on-street spaces so as not to excessively degrade the quality of the urban environment. Some transit agencies, such as AC Transit, have policies to develop park-and-Ride lots only in areas which passengers cannot easily access by walking to the bus.

Park-and-ride lots seem to be most effective for longer commutes that drivers find onerous, and for commutes into large, congested downtowns where parking is scarcer and more expensive.

Bay Area Rapid Transit (BART) Park-and-Ride lot sign in Oakland.

General Plan Language Ideas

» The City/County shall support public transportation facilities by requiring right-of-way for commuter rail or park-and-ride facilities, transit stops or facilities, or for other transportation needs.[1]

» The City/County shall study potential locations for park-and-ride facilities, considering commuting patterns, the locations of transit routes, and compatibility with the urban environment. The study shall examine the use of public land for new or expanded facilities; partnerships with private landowners who may be able to share excess parking; potential joint development opportunities (e.g., parking integrated with adjacent development); and the use of park-and-ride lots as "land-banking" for future development when market conditions warrant.

» The zoning code shall be amended to permit or encourage shops and services in and adjacent to transit centers and park-and-ride lots.

Implementation Ideas

» **Plan shops and services around park-and-ride lots.** Commuters often state that they can't carpool or take transit because they need a car to run errands before or after work. Developing shops and services around park-and-ride lots allows commuters to take care of errands at these sites, which makes park-and-ride more convenient and further reduces VMT. A 1998 Seattle study found that coffee shops, dry cleaning, and car care businesses rank as the most desirable nearby amenities.[2] Several studies report that retail and grocery options rank as the most attractive features of park-and-ride facilities.[3] King County Metro (metropolitan Seattle) has built transit-oriented housing developments at some of its park-and-ride lots.

» **Make park and ride lots transit hubs for their communities.** Park-and-ride lots typically have commuter service to the nearest major downtown, but they can be more useful if they are more comprehensive local transit hubs. Passengers to the downtown can arrive by bus as well as car and bicycle. Local passengers can transfer between various transit lines. If the park-and-ride is developed to have commercial or residential uses, local transit lines can serve those and increase the transit mobility of residents.

» **Install smart parking systems to increase lot use.** In high-demand areas, lots operate at or near capacity in peak times. Many commuters avoid park-and-ride lots for fear that space may not be available on that day. Intelligent parking space detection (or "smart parking") technologies such as inductive loop detectors, video image processing detection systems, vehicle license plate recognition, and radio frequency identification can provide commuters with real-time parking space availability. Many newer systems allow customers with cell phones to receive routing information, reserve a parking space, obtain access to a facility, and pay for parking electronically.[4]

» **Consider pricing at high-demand lots serving dense central business districts (CBDs).** High demand park-and-ride facilities that serve commuters traveling to dense CBDs may charge users without substantially cutting demand if the price is significantly lower than prevailing CBD parking rates.[5] Pricing can generate revenue for the municipality or transit system as well as encouraging people to use alternative modes of access (transit, bicycle, walk). Pricing is generally not as effective in a system serving lower-density CBDs, where transit may already be less competitive compared to driving. Pricing can also assure that transit agencies do not need to invest scarce resources maintaining park and ride lots, particularly when park and ride passengers may be more affluent than walk-up passengers.

» **Include bicycle racks and bicycle lockers** in park-and-ride design to facilitate bicycle access as an alternative to solo-driving (see strategy L.4.2 Bicycle Parking and Facilities).

» **Offer "kiss-and-ride" drop-off areas.** Many households share a vehicle but have different transportation needs during the day. In high-demand rail station park-and-ride lots, consider installing "kiss-and-ride" areas to accommodate drivers dropping off or picking up commuters.[6]

» **Size park-and-ride lots appropriately.** Small lots will not provide enough parking to justify frequent service, while large facilities can result in localized congestion and necessitate longer walking distances for commuters. Generally, people appear to accept walking up to 1,000 feet from their vehicles, but distances greater than 650 feet may result in illegal parking by some users.[7]

» **Ensure parking lot safety.** Commuters consistently rank safety as a key concern when choosing whether or not to use park-and-ride lots.[8] Locate lots within view of businesses or homes and with adequate light and security. In some cases, security cameras, fencing, and other improvements may be necessary.

Transportation Benefits

Use of park-and-ride lots varies by mode of transit. Park-and-ride lots associated with heavy rail systems (such as subways) typically experience high demand even if parking fees are charged. Studies of urban fringe park-and-ride lots reveal an average daily usage of 1.1 cars per space and 1.2 transit passengers per parked car, suggesting roughly 1.3 transit passengers (2.6 total trips) daily per space.[9] On commuter rail systems, parking lot utilization rates are often above 80 percent on weekdays.[10] However, park-and-ride lots are rarely used on weekends or for nonwork-related trips. On average, work-related trips account for 83 to 100 percent of total park-and-ride use.[11] Park-and-ride lots overwhelmingly serve central business district (CBD) commuters, while pool-and-ride lots tend to serve a larger share of commuters traveling to non-CBD destinations.[12]

Park-and-ride/pool-and-ride lots are intended to provide a means for travelers to switch from solo driving to a higher-occupancy mode such as carpool, vanpool, bus or rail. Generally, about one-half (40 to 60 percent) of rail park-and-ride facility customers previously drove alone to their end destination, while the remainder previously took the bus, carpooled, or took an alternate mode.[13] Use of cars to access transit stations is more pronounced in lower-density fringe areas. A 1992 survey of 35,000 BART heavy rail users showed that 50 percent of commuters to transit points in medium-density suburban areas were solo drivers, while 85 percent of commuters to exurban low-density stops were solo drivers.[14]

Customers accessing rail transit via automobile typically constitute a large share of total transit use. In the San Francisco Bay Area, 40 percent of Caltrain commuter rail customers and 39 percent of Bay Area Rapid Transit (BART) heavy rail customers use cars to access transit, while 23 percent of Light Rail customers in the Sacramento area use cars.[15] However, bus systems – even commuter bus systems – tend to attract a lower volume of driving customers because buses can provide service over a wider area. Many commuters will park off-site, often in residential neighborhoods, if a park-and-ride lot is full or unavailable. A 1998 study of BART customers who drive to transit stops revealed that 79 percent used an official park-and-ride lot while 21 percent parked off-site.[16] If off-site parking becomes a problem, a residential permit system may be implemented.

Generally, about half of rail park-and-ride facility customers previously drove alone to their end destination, while the remainder previously took the bus, carpooled, or took an alternate mode.[13]

Although they are successful at reducing urban vehicle traffic, park-and-ride facilities can increase vehicle traffic around suburban or exurban locations by attracting additional vehicles to the area.[17] Traffic around park-and-ride lots is typically highly peaked, with heavy arrival traffic in the morning and departure traffic in the afternoon/evening. In addition, larger facilities around transit stations can counteract efforts to enact transit-oriented developments (see strategy L.1.3 Transit-Oriented Development).[18]

Energy Savings and Environmental Benefits

Park-and-ride facilities will reduce VMT and energy consumption provided they lower vehicle trips (especially long-distance trips) from the system. Since park-and-ride is most effective where traffic and parking congestion are the worst, positive benefits can be significant.

However, park-and-ride lots are unlikely to have as great an impact on cold starts, in which vehicles release pollutants during the first several miles of travel, and hot soaks, in which vehicles release emissions after the vehicle is turned off. For a 10-mile automobile trip with 1990 emissions control technology, about 84 percent of hydrocarbon emissions and 54 percent of nitrogen oxide emissions result from cold starts and hot soaks alone.[19]

These issues may result in localized air quality issues around park-and-ride lots. Generally, however, well-planned park-and-ride facilities do reduce energy consumption and air pollution. An early study from the late 1970s estimated that the park-and-ride dependent San Bernardino Transitway (now the El Monte Busway) resulted in a seven to 10 percent reduction in energy consumption and a 10 to 20 percent reduction in air pollution emissions.[20] As low-emission technologies improve, emissions related to vehicle starts and parking should decline, resulting in further air quality benefits.

Economics

Park-and-ride lot construction can range in price from $2,000 per space for surface-level suburban lots with existing right-of-way to over $30,000 for urban underground lots.[21] Park-and-ride lots also require annual operating costs ranging from $250 per stall for low-amenity lots without supervision to over $2,000 per stall for structured parking with attendants.[22] Charging for parking at high-demand transit access points can generally recover about 35 to 75 percent of annual operating costs depending on lot location, capacity and use.[23]

From a regional cost-benefit perspective, the costs associated with constructing park-and-ride facilities will almost always be less than benefits due to the substantially higher cost of parking in city centers and lower land values at the periphery.[24]

Programs in Operation

Caltrans operates over 315 park-and-ride lots in California, with a total of over 31,000 spaces. Caltrans' largest park-and-ride lot (in Montclair) serves up to 1,700 vehicles, while its smallest lots serve only 10. The Los Angeles metropolitan area offers over 100 park-and-ride lots and over 18,300 total spaces; the San Francisco Bay Area offers 50 lots and over 5,000 spaces; San Diego offers over 60 lots and 3,900 spaces; and the Sacramento area offers nearly 40 lots and 2,300 spaces.[25] These numbers do not include many additional park-and-ride lots that are not operated by Caltrans.

A field study conducted between 2004 and 2006 on behalf of Caltrans installed parking space detection systems at a select number of parking spaces in a test park-and-ride lot at the Rockridge BART stop in **Oakland.** Peak-hour parking is at or near capacity at most of the 31 suburban BART stations. Some spaces were made available for advance reservations via computer or cell phone, while others were available for same-day access via changeable message signs (CMS) displaying the real-time number of available parking spaces to vehicles along CA-24.

An early study from the late 1970s estimated that the park-and-ride dependent El Monte Busway resulted in a 7 to 10 percent reduction in energy consumption.[20]

Motorists faced with congestion on CA-24 could check parking availability on the CMS and exit to take BART rather than wait in traffic. In a final survey of commuters, 30 percent responded that smart parking encouraged them to use BART rather than drive to work alone. The program attracted new users to BART, decreased average commuting time by 2.6 minutes, and reduced total VMT by 9.7 miles per participant per month.[26] Contact: Susan Shaheen, Policy and Behavioral Research Program Leader, Partners for Advanced Transit and Highways, University of California-Berkeley, (510) 665-3483, sashaheen@path.berkeley.edu.

Seattle, Washington and King County have been a focal point of growth over the past 30 years, which has strained existing transportation infrastructure. Seattle Transit opened the first area park-and-ride lot in 1970, and had a total of 126 by 1998. Use of King County park-and-ride lots more than doubled between 1980 and 1998, from 5,629 per day to 12,543 per day. Occupancy rates at permanent facilities have ranged between 71 percent and 89 percent, with several individual lots at capacity. Since 1995, the highest rates of growth in park-and-ride spaces and demand are in the surrounding counties.[27] Contact: Kevin Desmond, Metro Transit General Manager, (206) 684-1619.

Resources

Transit Cooperative Research Program (TCRP) Report 95, Chapter 3: Park-and-Ride/Pool (Transportation Research Board, 2004) examines traveler response to the introduction of park-and-ride lots at transit stations. Available on-line at http://trb.org/publications/tcrp/tcrp_rpt_95c13.pdf.

The Victoria Transport Policy Institute's Transportation Demand Management Encyclopedia offers a detailed on-line resource on parking pricing, suggested policies, and selected case studies: *Parking Pricing: Direct Charges for Using Parking Facilities.* Available on-line at http://www.vtpi.org/tdm/tdm26.htm.

NCHRP Synthesis 213: Effective Use of Park-and-Ride Facilities, is a 1995 National Cooperative Highway Research Project publication that provides an overview of park-and-ride including conceptual issues, location factors, demand estimate, design considerations, administration, operation, and other matters. It is available for purchase at http://books.trbbookstore.org/SYH213.aspx.

Related Strategies

L.1.1 Smart Growth Development
L.1.2 Land Use Diversity
L.1.3 Transit-Oriented Development
L.1.4 Design Sites for Pedestrian and Transit Access
L.2.2 Parking Supply Management
L.4.2 Bicycle Parking and Facilities
T.2.1 Transportation Demand Management Programs
T.2.4 Ridesharing

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TRANSPORTATION DEMAND MANAGEMENT PROGRAMS

Transportation Demand Management (TDM) can be defined as a set of strategies that strive to either reduce or reallocate automobile travel to achieve benefits such as reduced roadway congestion, reduced environmental impacts, and reduced travel costs. In contrast to conventional policies that focus primarily on roadway expansion to ease vehicle congestion, TDM strategies achieve transportation benefits by shifting travelers to the most efficient and lowest-cost means of travel for a particular trip.

Implementing a municipal TDM program to encourage city and county employees to switch from driving alone to walking, bicycling, transit, ridesharing and telecommuting can save energy, reduce greenhouse gas emissions, and provide a model for other local employers to do the same. Municipalities can also develop programs targeted at businesses, workers, and residents to encourage businesses to implement trip reduction measures at their worksites, and to provide workers and residents with the information and incentives they need to travel by alternative modes. TDM is often focused on work-related travel, but can be applied to other travel purposes as well, such as school trips.

This section provides an overview of several TDM strategies, such as guaranteed ride home programs; ridesharing; carsharing; telework; and alternative work schedules. More detail on these strategies is provided in the guidebook sections on each topic.

The efficiency gained by TDM policies can help:

- **Save on the rising costs of road and parking facility expansion;**
- **Reduce greenhouse gases;**
- **Save on increasingly volatile vehicle fuel costs and reduce dependence on fossil fuels.**
- **Increase access for elderly, low-income and disabled individuals who lack access to cars;**
- **Accommodate consumers who prefer living in communities with multi-modal transportation opportunities;**
- **Improve public health through greater physical activity and the use of non-motorized modes; and**
- **Limit air pollution, sprawl, and other environmental impacts associated with the single-occupant vehicle.**

General Plan Language Ideas

» The City/County shall adopt a comprehensive program to encourage City/County employees to commute by modes other than the single-occupant vehicle, including walking, bicycling, transit, carpooling, vanpooling and telecommuting. The objective of the program will be to increase the average vehicle ridership (AVR) to 1.5 by [date] and 1.75 by [date]. (AVR is generally defined as the number of employees reporting to a worksite divided by the number of vehicles driven by those employees to the worksite.)

» The City/County shall establish preferential parking provisions in the Zoning Ordinance for carsharing and for carpoolers and vanpoolers.

» The City/County shall establish a home-based telework program for City/County employees to attempt to reduce employee commute trips.

» The City/County shall establish a guaranteed ride home program in order to promote ridesharing among City/County employees and serve as a model for other local employers. Large employers shall be required to establish guaranteed ride home programs or participate in existing programs.

» The City/County shall work with local and regional transportation demand management services to explore opportunities for vanpool sponsorship.

» The City/County shall require all employers with 50 employees or more to submit annual "employee trip reduction plans," including alternative work schedule options, and to report annually on the implementation of their plans.

» The City/County shall develop an information and outreach program to encourage businesses and other major trip generators to implement trip reduction measures and provide information and other resources to support alternative modes of travel.

Implementation Ideas

» **Conduct an employee survey.** Determine how employees currently get to work, where they live and what commute options they might consider. Contact your regional ridesharing agency for assistance. Based on survey results, design an employee trip reduction plan.

» **Hire/appoint an employee transportation coordinator (ETC)** to oversee and coordinate commute trip reduction efforts in the city/county.

» **Require or provide incentives to developers to reduce vehicle trips.** Require larger developments to adopt a transportation reduction program such as offering free or preferential carpool and vanpool parking, bicycle lockers and showers, or other incentives to promote alternative modes.

» **Distribute transit and ridesharing information.** Establish a permanent display in all city/county buildings. Include transit and ridesharing information in new employee packets (regional transit and ridesharing agencies usually have free promotional materials to post and distribute). Distribute rideshare matching forms annually from the regional ridesharing agency to all employees and to all new employees. The ETC can also perform personalized rideshare matching.

» **Provide bicycle lockers and showers** (see strategy L.4.2 Bicycle Parking and Facilities).

» **Provide preferential parking to carpools and vanpools.** If employees are charged for parking, reduce rates for carpools and vanpools. Designate covered spaces and spaces closer to buildings for pool vehicles.

» **Cash out free parking** (see strategy L.2.1 Parking Pricing).

» **Offer incentives to employees who do not drive alone.** Offer employees who don't drive alone extra leave time and enter their names in weekly drawings for cash and/or prizes. Offer gift certificates from designated vendors or leave time. Provide bicycling and walking commuters the same financial subsidy as that given to commuters using transit or ridesharing.

- **Offer a Guaranteed Ride Home program** (see strategy T.2.3 Guaranteed Ride Home Programs).

- **Subsidize bicycles and walking.** Reimburse employees using bicycles for city business by the mile, just as you would an official vehicle trip. Offer bicycles and helmets for work-related trips made during the day. The City of Santa Ana offers employees who travel to work by bicycle or walking an allowance up to $45/month. The allowance amount is determined by the number of times the employee bicycles or walks.

- **Establish a telework program for government employees** (see strategy T.2.6 Telework). Include training of both employees and managers. In many cases, employees already will have computers or may not need them to perform their work. Otherwise, the city/county should purchase computer equipment, establish special discounts or loan programs so employees may purchase their own computers, loan employees laptop computers, or move existing computers from offices to homes. Allow appropriate employees such as building inspectors to go directly to a site from home in the morning, rather than driving to the office first.

- **Reduce the cost of transit.** Establish a flexible spending account for transit (bus, train and vanpool) costs. Employers may provide workers with up to $230 per month in tax-free transit and vanpool benefits in 2009 (under Section 132(f)(2)(A) Qualified Transportation Fringe Benefits). The monthly tax-free benefit limit for qualified parking is also $230. Commuters can receive both the transit and parking benefits (i.e., up to $460 per month). Employers can allow employees to use pretax dollars to pay for transit passes, vanpool fares and parking.

- **Provide monthly subsidies for train and bus passes and vanpools.** Sell transit passes at the work site.

- **Establish a vanpool program.** Purchase vans to operate a program or invite a private company to organize vanpools for city employees (see strategy L.2.4 Ridesharing). Note that if vanpools are only available to city employees or any singular employer, they may not be eligible for agency subsidies that usually require vanpools to be open to the public. Vanpools can also be formed by commuters without requiring employer participation.

- **Establish a ridematching database.** A ridematching service is a database that matches those who need rides with those who are willing to provide them. If such a service is not already provided by a regional agency, it could be established to help match workers with compatible rideshare arrangements or people they could ride with. Web-based services can be established at modest cost. A ridematching service may be provided as part of a broader set of municipally sponsored commuter assistance services.

- **Offer alternative work schedules to employees** (see strategy T.2.7 Alternative Work Schedules).

- **Participate in a Transportation Management Association (TMA).** A TMA is an organization of several employers who pool resources to reduce employee trips (see strategy T.2.2 Transportation Management Associations).

- **Locate new municipal facilities within walking distance of transit.** New or relocated facilities should be accessible by transit for employees and visitors.

- **Develop an outreach program to local employers, schools, and other major trip generators.** Municipal staff or consultants can contact employers and other agencies to identify their potential interest in TDM, identify opportunities for trip reduction at their particular location, develop a customized trip reduction plan, and connect them with resources to reduce trips and provide commuter benefits to their employees.

» **Establish a commuter assistance program or a "commuter store"** to provide "one-stop shopping" for information on alternative commute options; commute items such as transit passes, messenger bags, bicycle locks, umbrellas, and maps; and registration for carpool, vanpool, and reward programs.

Transportation and Energy Benefits

One study of 50 successful employer programs throughout the United States found the average daily vehicle trip reduction among successful programs to be 15.3 percent.[1] Programs that focused on support, promotion and information realized a net trip increase of 1.4 percent; programs that provided services such as commuter vanpools and shuttle buses realized an 8.5 percent reduction in trips; and programs that focused on financial incentives and disincentives realized a 16.4 percent vehicle trip reduction. Programs that combined incentives and the provision of alternatives were by far the most effective, realizing a 24.5 percent vehicle trip reduction.

A 1999 synthesis of TDM experiences in the United States concluded that the right mix of strategies at individual employment sites could reduce work-related vehicle trips by as much as 30 to 40 percent.[2] A 2004 evaluation by the U.S. Environmental Protection Agency showed that companies offering comprehensive benefit packages that included financial incentives, services (such as guaranteed ride home, rideshare matching, etc.) and informational campaigns reduced employee vehicle trip rates by roughly 15 percent compared to average commute mode shares for the surrounding area.[3]

Another recent study used employer plan data from California, Washington, and Arizona, to estimate a typical prediction for vehicle trip reduction on the order of three to six percent. The lower reductions found in this study can be attributed to the fact that the much larger employer sample includes all employers affected by the TDM requirements – not just the most aggressive or "exemplary" examples which are often documented in case studies.[4]

Each commute trip avoided could save gallons of gasoline each day, depending upon the distance and whether the person drives to a park-and-ride location. The feasibility

Translating Percent Trip Reductions into Reductions in Vehicle Miles Traveled

Research on the effectiveness of TDM strategies sometimes presents effectiveness in terms of the percent of commute trips reduced by the strategy. In some cases, it is helpful to translate that information into a measure of vehicle miles traveled reduced, which is more easily converted into greenhouse gases reduced.

The percent of commute trips reduced by the strategy can be multiplied by an average commute trip length in miles to obtain a rough estimate to the total miles reduced by the strategy. So for example, to estimate the potential vehicle miles traveled reduced by a TDM strategy at a given worksite, multiply:

Number of employees at the worksite * average one-way commute trip length * 2 commute trips per day * percent reduction in trips expected

For a worksite with 100 people where a TDM strategy is expected to reduce average daily work trips by 15 percent, and an average commute trip length of 12 miles, the expected total reduction in Vehicle Miles Traveled per day would be:

100 Employees * 2 Trips per day * 12 miles per trip * 15 percent expected reduction = 360 vehicle miles traveled per day reduced due to the TDM program.

The average one-way vehicle commute trip in the United States is about 12.1 miles, according to the 2001 National Household Transportation Survey. However, the length varies by geographic location.

of using alternative modes will vary depending on the site. If transit service is poor, carpooling, vanpooling, and alternative work schedules will be the most viable options. If most employees live within 10 miles, ridesharing may not be as effective as promoting local transit, bicycling and walking. Carpooling and vanpooling will also be most effective at large employment sites, where employees have many options for ridematching.

Environmental Benefits

Reducing single-occupant vehicle (SOV) commuting reduces air pollution. A former SOV commuter who telecommutes, bicycles, or walks instead can eliminate all former emissions. The benefits of other modes vary. For instance, an employee drives to a park-and-ride location must still start their car in the morning and evening, usually with a cold engine that emits significant pollution.

Replacing a 20-mile SOV commute with a two-mile drive to a park-and-ride lot or transit station reduces greenhouse gas emissions by at least 85 percent.[5] If the employee uses a feeder bus, bicycle or walks to an express bus or rail stop, emissions are reduced up to 100 percent. These savings can help regions to meet state and Federal air quality standards.

Economics

Trip reduction programs tend to cost far less than capacity expansion projects.[6] The cost of a trip reduction program depends upon the incentives adopted. Implementation costs might include staff time, monetary and other incentives, bicycle racks, telecommuting equipment and promotional materials.[7] Programs with monetary incentives will cost more, but tend to be more effective at reducing VMT.

TDM policies can help save on the rising costs of highway and parking facility expansion and increasingly volatile fuel costs. Employees will save money by using alternative modes and can eliminate the need for a second car. The American Automobile Association estimates new car costs at 45.3 to 70.7 cents per mile, including operating and ownership costs. Operating costs range from 13.1 to 17.3 cents per mile, not including parking charges or tolls. Ownership costs range from about $4,350 to $7,300 per year, including insurance, license, registration, taxes, depreciation and finance charges.[8]

Programs in Operation

The City of **Pasadena's** Trip Reduction Requirements and Transportation Demand Management Program, first adopted in 1993, requires both new and existing employers to develop a TDM program and report annually on its implementation. The program must include rideshare options and provision of information, as well as other measures. The program includes targets for average vehicle ridership (AVR).

The South Natomas Transportation Management Association (TMA) in **Sacramento** allows developers to participate in TDM reduction programs in order to gain municipal support for new developments.

As part of its 2006 Greenhouse Gas Reduction Program, **Marin County** expanded community bicycle infrastructure, expanded its Safe Routes to Schools program, and encouraged telecommuting, carpooling, and vanpooling by municipal employees.[9] County employees who walk, bicycle, or take public transit to work receive an extra $4 per day (up to $20 per week) when they walk, bicycle, take public transit or carpool to work. About 15 percent of county employees participate in the program.[10]

The City of **South San Francisco's** TDM program requires all development projects that generate 100 or more trips to achieve a minimum 28 percent alternative mode by offering incentives such as free and preferential parking for carpools and vanpools.

The City of **Alameda** requires businesses with 50 or more employees to adopt a trip reduction program, which includes preferential parking for ridesharing participants, among other measures.

Resources

The *Employee Transportation Coordinator Handbook,* published by the Washington State Department of Transportation in November, 2000, offers a guide to employers interested in hiring an employee transportation coordinator. Available on-line: http://www.greenbiz.com/files/document/O16F7812.pdf.

Public Agency Guidance on Employer-Based TDM Programs and Employer Technical Memorandum Characteristics of Effective TDM Programs, prepared for Transit Cooperative Research Program by Comsis Corporation, provides an on-line resource for public agencies interested in enacting employer sponsored TDM programs. Available on-line: http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_webdoc_22-a.pdf.

The Commuter Choice Resource Toolkit (2002), published by Clean Air and Transportation, Inc., is a step-by-step resource for local governments interested in implementing transportation demand management programs. The toolkit includes guidance on employer and employee communications, potential commuter choice incentives, media outreach, and funding possibilities. Available on-line: http://www.edf.org/documents/2281_CCToolkit.pdf.

The Association of Commuter Transportation (ACT) is a membership organization of professionals involved in alternatives to solo-commuting, including transportation coordinators from throughout the country. The ACT manages www.CommuterChoice.com, which provides information on linking employers with alternative transportation options.

Metropolitan planning organizations (MPO) operate a number of regional TDM Programs. For instance, the San Diego Association of Governments (SANDAG), the MPO for San Diego County, employs eight full-time staff to run its TDM program, RideLink (available on-line at http://www.ridelink.org).

Related Strategies

L.2.1	Parking Pricing
L.2.2	Parking Supply Management
L.4.2	Bicycle Parking and Facilities
T.2.3	Guaranteed Ride Home Programs
T.2.4	Ridesharing
T.2.6	Telework
T.2.7	Alternative Work Schedules

Endnotes

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TRANSPORTATION MANAGEMENT ASSOCIATIONS

A transportation management association (TMA)[1] is a public/private partnership organization comprised of employers, developers, building owners, local government representatives and others who work together to address local transportation problems. TMAs address problems by: 1) providing services (e.g., carpool matching, guaranteed ride home programs, telework support); and/or 2) providing a forum for private interests to participate in public planning and decision-making. TMAs are usually formed in an area of concentrated employment, such as a downtown or suburban employment center. Local governments can play a key role in the establishment and ongoing support of a TMA.

San Luis Obispo County's Ride-On Program offers rides to and from lunch destinations.

General Plan Language Ideas

» The City/County shall help establish transportation management association(s) in existing areas of concentrated employment. The goal of the TMA(s) will be to reduce automobile travel and relieve traffic congestion in the area through cooperative efforts of employers, building owners, business organizations, developers, the City/County, the rideshare agency, and transit providers.

» Specifically, the City/County shall: 1) survey and convene a meeting of local major employers, business interests and building owners to assess interest in forming a TMA; 2) work with interested parties to identify funding sources; 3) provide direct funding; 4) as a major employer, become an active member of the TMA; 5) provide other assistance, as necessary.

» The City/County shall require TMAs in new developments of over 500,000 square feet. In addition, the City/County shall require developers of new buildings in areas with TMAs to participate in the TMA.

Implementation Ideas

» **Identify potential locations.** Downtown and any other concentrated centers of employment within well-defined geographic areas are potential locations for a TMA. Most TMAs cover areas with at least 10,000 employees. Areas experiencing high growth and/or traffic congestion are prime targets. In smaller cities, a single TMA may cover the entire jurisdiction.

- **Survey interest in TMA formation.** Work closely with existing business organizations and key employers in the area. With their support and assistance, conduct a mail or phone survey and/or convene a meeting of employers, building owners, and developers to identify issues and assess the interest in forming a TMA. Emphasize that the TMA would be an independent, public/private partnership, not just a city/county committee.

- **Contact and involve local resources.** Local transit providers, the rideshare matching agency and other TMAs in the region can provide expertise and advice.

- **Assist in the formation of a TMA.** If strong interest exists, work with a core group of employers, developers and other business interests to form the TMA. Most TMAs operate as private, non-profit entities. Recruit a board of directors and hire an executive director, once funding is secured.

- **Identify TMA activities.** TMAs can provide a variety of programs: rideshare matching; transit pass sales; vanpool services; transportation fairs and information; shuttles to nearby shopping, housing, and/or transit stations and guaranteed ride home programs. Other activities may include: acting as a liaison with local transit providers to improve service; providing parking supply management services; offering centralized bicyclist lockers and shower facilities in an office park; providing a sounding board for city/county decision-making and promoting compressed work weeks, telework, parking incentives and other trip reduction strategies to individual employers. TMAs may also conduct employee surveys to track program progress.

- **Help secure TMA funding.** Membership fees should be established and businesses may be asked to commit additional start up funding or in-kind contributions such as office space, administrative services, and reproduction of materials. Local governments can provide direct financial assistance to start up the TMA through general revenue funds, traffic impact fees, one half-cent sales tax funds or vehicle registration fees (in some areas, through air districts). In addition, a local government can cooperate with TMA organizers to apply for grant funding. In the long run, TMAs that are market-driven and self-supporting are usually the most successful.

- **Require TMAs in new, large-scale developments.** As a condition of approval of new, large-scale commercial developments, require the formation of a TMA to coordinate trip reduction strategies. To monitor effectiveness, require annual reports to the council/board. The city/county could also serve as a non-voting member, if city/county facilities are not within the TMA's area.

- **Require TMA participation by new developments.** In areas with existing or proposed TMAs, require new building owners to participate as a condition of development approval.

Transportation and Energy Benefits

TMAs are an implementation tool for other transportation demand management (TDM) strategies such as ridesharing, transit incentives and guaranteed ride home programs. By coordinating TDM programs among several individual employers, a TMA can make such programs less costly and more effective at reducing vehicle miles traveled (VMT).

For example, most individual employers cannot afford to provide shuttle service, guaranteed ride home programs or teleconferencing centers. By pooling the resources of several employers, programs like these can be implemented at low cost to individual businesses. Other programs such as rideshare matching and vanpools may be more effective due to the larger pool of employees from which the programs can draw. Promotional materials may be produced in larger volumes at a lower cost, adding to the effectiveness of the overall TDM program.

In addition, TMAs can provide parking management services. For example, a TMA can broker a deal in which a church allows a restaurant to use its parking on Saturday night in exchange for the restaurant offering its parking to the church on Sunday morning.[2] TMAs may also be instrumental in enacting parking pricing strategies.[3] This more efficient use of resources can reduce the demand for unnecessary parking projects.

A 1996 study estimated that TMAs can reduce six to seven percent of total work-related trips in an area. Implementing TMAs in conjunction with other TDM strategies can further reduce VMT.[4]

Environmental Benefits

TMAs do not directly improve the environment, but can orchestrate and boost the effectiveness of VMT reduction efforts by implementing and coordinating trip reduction strategies. TMAs provide communities with a mechanism to account for costs and benefits and to integrate otherwise piecemeal strategies aimed at relieving traffic congestion and reducing carbon monoxide, carbon dioxide and smog-forming pollutants such as volatile organic compounds and nitrogen oxide.

Economics

TMA costs will depend upon the organization's size and the services provided. Expenses generally include office operations, marketing, and service provision, with marketing services comprising the largest expense in a TMA's first year and office operations comprising the biggest share in later years. Typical revenues include member dues, grants and subsidies, service fees, and developer funding agreements. The median annual budget for TMAs in the United States was approximately $200,000 in 2003.[5] In-kind contributions and providing ridesharing subsidies and shuttle services can affect the overall budget significantly.

Programs in Operation

The **Anaheim** Transportation Network (ATN) is a TMA that offers TDM program support to employers in Anaheim. In addition to providing rideshare services, ATN operates Anaheim Resort Transit, a bus service that connects visitors with area attractions, including the Convention Center, Disneyland, Angel Stadium, shops, restaurants, and the Metrolink and Amtrak rail systems. New registered ridesharing members receive $2 for each reported day of ridesharing for up to three months. More information available at http://atnetwork.org.

511 Contra Costa is a TMA serving all 20 jurisdictions in **Contra Costa County** through four regional planning committees for the southwest, central, east, and west regions. 511 Contra Costa is funded primarily by the Bay Area Air Quality Management District's Transportation Fund for Clean Air, and a half cent sales tax established by voters in 1988. 511 Contra Costa offers free bicycle racks and lockers to employers, as well as workshops, trainings, and consultations to employers and employees on strategies and programs for reducing VMT. More information available at http://www.511contracosta.org.

The **Glendale** TMA was formed by the City of Glendale, the Chamber of Commerce and a consortium of local business leaders and community organizations. The TMA was launched with an initial $83,000 city grant using funds from a countywide sales tax and a $60,000 grant from Caltrans. In addition to vanpool, carpool, guaranteed ride home, and shuttle services, it offers consulting and workshop services to employers on telework, flexible work schedules, and strategies to make efficient use of existing parking facilities. More information available at http://www.glendaletma.net.

The **Sacramento** TMA represents 162 employers and 87,153 commuters in the downtown Sacramento area. It was founded in 1989 by employers concerned about the negative impact of traffic congestion and air pollution on employee commutes and quality of life. Sacramento TMA offers vanpool services, rideshare matching, information on park-and-ride lots and bicycle paths, and an emergency ride home program. More information is available at http://www.sacramento-tma.org/index.htm.

San Luis Obispo County's Ride-On program is a nonprofit transportation management association created in 1993. Its mission is to provide affordable transportation to the people and employers of San Luis Obispo County. In 1995 Ride-On merged with SLO Regional Rideshare to expand its TDM services. Ride-On has a fleet of over 90 vans and buses, and offers guaranteed ride home, vanpool services, and shuttle services. In addition, a Lunchtime Express bus may be reserved for parties of two or more for carpools to participating restaurants. More information is available at http://www.ride-on.org.

Resources

The *TMA Handbook: A Guide to Successful Transportation Management Associations*, produced by National Center for Transit Research with the assistance of the Association for Commuter Transportation's TMA Council, provides useful information on how to start a TMA. Available on-line at http://www.nctr.usf.edu/clearinghouse/pdf/tma_handbook_final.pdf.

The Association for Commuter Transportation (ACT) is a nonprofit organization that supports TDM programs including TMA formation. Available on-line at http://www.actweb.org.

The Victoria Transport Policy Institute's Transportation Demand Management (TDM) Encyclopedia offers a detailed on-line resource on transportation management associations, best practices, and selected case studies: *Guaranteed Ride Home: A Backup for Commuters who use Alternative Modes.* Available on-line at http://www.vtpi.org/tdm/tdm44.htm.

Related Strategies

L.2.2	Parking Supply Management
L.4.2	Bicycle Parking and Facilities
T.2.1	Transportation Demand Management Programs
T.2.3	Guaranteed Ride Home Programs
T.2.4	Ridesharing
T.2.6	Telework
T.2.7	Alternative Work Schedules

Endnotes

1. Also known as Transportation Management Organizations (TMO).
2. VTPI. 2008. "Transportation Management Associations." *TDM Encyclopedia.* Victoria, BC: Victoria Transport Policy Institute. http://www.vtpi.org/tdm/tdm44.htm.
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ENERGY AWARE PLANNING**GUIDE** T.2.3

GUARANTEED RIDE HOME PROGRAMS

Ridesharing, sometimes called carpooling, is a good way to reduce overall VMT. However, the difficulty of getting home in the case of an emergency or unexpected overtime work prevents some people from participating. Guaranteed Ride Home (GRH) programs address this problem by offering employees an alternative way to get home. GRH programs act as a safety net to employees, providing them a ride home (e.g., taxi or rental car) in case of a qualified emergency or unexpected overtime. Governments can offer GRH programs to their own employees and require or encourage other employers to offer such programs.

Most GRH programs require employees to use alternative commute modes a minimum number of times per week. Government employees in Monterey must use alternative modes to commute at least once per week to qualify, while Sacramento employees must do so at least three times per week to qualify for GRH benefits.[1] Some other programs require only that the employee use an alternate mode on the day that a GRH is requested. Most programs offer a GRH by taxi only, while others reimburse the costs of rental cars or offer agency cars in the event of an emergency.

General Plan Language Ideas

» The City/County shall establish an in-house guaranteed ride home program or participate in existing programs in order to promote ridesharing among City/County employees and serve as a model for other local employers.

» The City/County shall require large employers to establish guaranteed ride home programs or participate in existing programs. This may be done via a trip reduction ordinance and/or conditions upon specific developments with major traffic impacts.

Implementation Ideas

» **Establish a GRH program for city/county employees.** Programs may use taxis, fleet cars, backup carpools and vanpools, short-term auto rentals, and/or transit to provide rides to employees. Rides should be offered in case of emergency (e.g., sick children) and could be offered in case of unexpected overtime. GRH programs tend to be used infrequently. A 2007 survey indicates that GHG programs are used by an average of 4.6 percent of registered participants, with a majority of programs experiencing usage rates of less than two percent.[2] Employees could be charged nominal copayments per ride or limited to a certain number of rides per year in order to discourage abuse. Programs must be accessible to the mobility-impaired.

» **Educate employers about GRH programs.** In addition to using the city/county program as a model, provide GRH literature or workshops for local employers.

» **Require GRH programs for large developments** as a traffic mitigation measure, along with other ridesharing measures. Including GRH programs in the general plan helps to enforce such conditions.

» **Implement a GRH program along with other travel demand management (TDM) efforts** to provide congestion mitigation during large construction projects. Reducing congestion is particularly important during the construction of key transportation arteries, which can result in large increases in area delay and GHG emissions. Enacting a corridor-specific construction mitigation program that offers GRH along with ridesharing and other measures during construction can ease congestion during capacity expansion projects.

» **Subsidize local or regional GRH programs.** In some areas the transit agency, ridesharing agency or transportation management association (TMA) may be interested in setting up a GRH program for all employees in an area, not just individual employers. Local governments can help subsidize such programs.

Transportation and Energy Benefits

GRH programs typically act as an insurance policy for ridesharers and are one of a number of factors that determine commute behavior. GRH programs grant security to commuters worried about getting home in the event of an emergency, and provide increased flexibility to those who may need to stay late at work. This added security may have a significant impact on VMT reduction. A study for the California Air Resources Board found that GRH programs are among the most important factors in reducing work-related vehicle miles traveled (VMT).[3] Another study found that GRH programs have roughly the same effect on reducing work-related travel as subsidizing transit fares, but are offered at a fraction of the cost.[4] A 2007 evaluation of the Alameda County Congestion Management Agency's GRH program found that 41 percent of respondents would not use alternate modes without GRH.[5]

Environmental Benefits

Reducing solo commuting will result in a decline in greenhouse gas emissions. If solo commuting is reduced two percent as a result of GRH program, air emissions attributed to commuting could be expected to fall by slightly less than two percent. This is because some of the people shifting to other modes will still need to use their car, either to reach a park-and-ride location or for ridesharing. GRH programs provide valuable support for other trip reduction policies, and generally contribute to participation in alternative modes of transportation.

Economics

The total cost of a GRH program consists of administrative costs plus the total cost of rides administered to participants. Administrative costs may include processing reimbursements, marketing, and evaluation. Reimbursement costs vary depending on the number of participants and whether they are required to provide copayments. Most programs devote a majority of the budget to marketing.[6]

Costs to employers will depend upon the type of transportation used for rides and eligibility requirements. In a 2007 survey of 55 transit agencies that offer GRH programs, the average cost per GRH claim was $36.95. The average cost per participant was $1.69. Among programs surveyed in California, San Francisco reported the lowest average cost per commuter at $0.02, while Contra Costa County reported the highest cost per commuter at $13.16.[7]

The cost of subsidizing local or regional GRH programs depends upon the extent of the program and the amount of the subsidy. Costs may be shared by other agencies, participants, and employers.

Programs in Operation

The **Alameda County** Congestion Management Agency (CMA) offers a free guaranteed ride home service to County employers who have 75 or more employees, or who are part of a registered business park. As of December 31, 2007, 155 employers and 4,437 employees were registered with the program. Eligible employees must be permanent and live within 100 miles of their worksite. The Alameda County CMA reimburses an emergency taxi fare for distances under 20 miles. The CMA has also partnered with Enterprise car rental to provide free delivered car rentals for distances greater than 20 miles (participants must pay for gas). Employees and employers must register on-line at http://grh.accma.ca.gov/.

The **Altamont Commuter Express (ACE)** provides heavy rail commuter service from Stockton to San Jose through the Altamont pass. The ACE Emergency Ride Program provides options to ACE passengers who must return early due to illness, the illness or accident of an immediate family member, or a home emergency such as fire or theft, provided the individual commuted via ACE that day. Participants can call an emergency number, 800-411-RAIL, to be provided emergency ride options on a case-by-case basis. These options can include alternate trains, buses, shuttles, or taxi. Under the Emergency Ride Program, eligible passengers will be provided a ride from their destination station back to their station of origination. More information is available on-line at http://www.acerail.com.

The **San Diego** Association of Governments (SANDAG) offers a Guaranteed Ride Home initiative through its RideLink regional commuter services program. Registered commuters who use carpool, vanpool, bicycle, the COASTER commuter rail, or Premium Express Bus service at least three times per week are eligible. Rides can be redeemed by a call to the 511 transportation information line. Rides of under 12 miles are eligible for taxi fare reimbursement, while other rides are fulfilled via rental car. A copayment of $3 is required. Participants are eligible for up to three emergency rides per year. More information is available on-line at http://www.ridelink.org.

The **San Luis Obispo** Council of Governments (SLOCOG) offers a Guaranteed Ride Home service as part of its Regional Rideshare initiative. Registered participants who call an emergency number (541-TRIP) in the event of sudden illness, a child's illness, unexpected late work, or other emergency, will be picked up by a SLOCOG-sponsored "Ride-On" van within 30 minutes for destinations is within San Luis Obispo County or the City of Santa Maria. There is a $4 copayment per ride. Employees of the County and other sponsoring employers are exempt from the copayment. More information is available on-line at http://www.rideshare.org.

Resources

The Victoria Transport Policy Institute's Transportation Demand Management (TDM) Encyclopedia offers a detailed on-line resource on guaranteed ride home programs, suggested policies, and selected case studies: Guaranteed Ride Home: *A Backup for Commuters who use Alternative Modes.* Available on-line at http://www.vtpi.org/tdm/tdm18.htm.

Menczer, William B., "Guaranteed Ride Home Programs: A Study of Program Characteristics, Utilization, and Cost," *Journal of Public Transportation,* Vol. 10, No. 4 (2007) presents the results of an extensive survey of 55 GRH programs that serve the top 150 transit agencies in the United States. It offers a review of innovative programs as well as average and median cost and usage rates. Available on-line at http://www.nctr.usf.edu/jpt/pdf/JPT%2010-4%20Menczer.pdf

Related Strategies

T.1.1	Transit Fare Measures and Discounts
T.2.1	Transportation Demand Management Programs
T.2.2	Transportation Management Associations
T.2.4	Ridesharing

Endnotes

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RIDESHARING

Ridesharing is one of the most cost effective and common alternative modes of transportation, particularly in regions not served by public transportation. Ridesharing, in which vehicles carry more than one passenger, can be accomplished through carpools or vanpools. Carpools utilize privately owned vehicles, while vanpools generally utilize vans supplied by private vanpool companies, government agencies, or employers. Ridesharing programs can significantly reduce vehicle miles traveled (VMT) for work-related trips.

Local governments can take a number of steps to increase the use of ridesharing as a viable alternative to single occupant vehicles (SOVs), including administering programs to municipal employees and sponsoring outreach and assistance programs run by municipal or regional agencies and transportation management associations (TMAs). Often these programs are part of a larger set of services to assist commuters in using alternative modes of travel.

General Plan Language Ideas

- The City/County shall work with employers to provide transportation demand management programs that encourage employees to rideshare and use alternative modes of transportation.
- The City/County shall sponsor a vanpool program for municipal employees.
- The City/County shall work with local and regional transportation demand management services to explore opportunities for vanpool sponsorship.
- The City/County shall work with groups such as the Convention and Visitors Bureau and the Chamber of Commerce to promote the use of ridesharing to and within the City/County in advertising and promotion efforts.[1]

Implementation Ideas

- **Establish a ridematching database.** If a ridematching service is not already provided by a regional agency, the municipality can establish a ridematching database to help match workers with compatible carpoolers. Web-based services can be established at modest cost. A ridematching service may be provided as part of a broader set of municipally sponsored commuter assistance services.

» **Establish casual carpool sites.** Casual carpool locations are meeting points at which drivers can pick up commuters to take advantage of HOV lanes. Casual carpools are most effective in the a.m. commute since coordinating return trips is often difficult; transit is usually taken for riders in the p.m. commute.[2]

» **Provide preferential parking for carpoolers and vanpoolers.** Development approvals can be written to require the provision of "preferential" carpool and vanpool parking spaces (i.e., those spaces closest to the building entrance). Municipal agencies can also provide preferential parking at their own sites.

» **Establish park-and-ride lots near transit access points** (see strategy T.1.3 Park-and-Ride Lots). Provide preferential parking for carpools and vanpools.

» **Establish parking cash-out programs,** in which commuters who are offered free parking are also offered a cash equivalent if they use alternative modes of travel.

» **Offer flexible scheduling options to rideshare participants.** Allow employees to flex their start and end work hours utilize public transit, carpools and vanpools (see strategy T.2.7 Alternate Work Schedules).

» **Offer an empty seat subsidy.** Temporarily subsidize a share of vanpool costs if the vanpool looses a rider.[3] This may be impossible if the agency requires that a certain percentage of riders ride 100 percent of the time to be eligible for a subsidy.

» **Engage in direct marketing.** Vanpool providers can call households in a particular suburb with an offer of a month of free vanpooling to encourage participation.

» **Target areas with high occupancy vehicle (HOV) lanes on congested highways.** HOV lanes are off limits to single occupant vehicles during peak periods, and serve as an incentive to carpool or vanpool to and from work. Most HOV lanes carry more people per lane than adjacent freeway lanes in the peak hour, if not the entire peak period. During the a.m. peak hour, State Route 91 carries 3,000 occupants into downtown Los Angeles in only 1,300 vehicles.[4]

» **Promote guaranteed ride home (GRH) programs.** GRH programs offer ridesharing participants a complementary or subsidized ride home in the event of an emergency (for more information see strategy T.2.3 Guaranteed Ride Home).

» **Reduce parking minimum requirements.** Readily available and cheap parking can reduce the demand for ridesharing, yet zoning codes often mandate high minimum parking requirements. Typical minimum parking requirements range from three to four spaces per 1,000 square feet, which far exceeds normal utilization, estimated at an average of 2.2 parked vehicles per square foot.[5] Reducing minimum requirements is particularly appropriate where codes call for more parking than is utilized (such as suburban office parks), in mixed-use developments, and where transit is a viable alternative.

» **Implement as part of a comprehensive transportation demand management (TDM) program** (see strategy T.2.1 Transportation Demand Management Programs).

Transportation Benefits

VMT reductions can be sizable since carpool and vanpool passengers tend to have long commutes (the average vanpool trip length according to the 2001 National Household Travel Survey was 20.4 miles, compared to 12.2 miles for all work trips). Due to the general inflexibility of user schedules, ridesharing is usually suitable only for trips with predictable schedules such as a.m. and p.m. commute trips or attending special events. Rideshare matching programs offer potential carpool participants a way to join commuters with similar routes and schedules. Many programs use computerized matching systems that incorporate commuter origins, destinations, schedules and special needs to better match individuals with rideshare partners. Larger areawide programs are generally better at finding matches since they have a larger commuter pool.

Carpooling represents the second most common commuting mode in the U.S., with a mode share of 12.2 percent according to the 2000 Census. However, the majority of carpooling is informal – over 60 percent percent is in two-person carpools with family members.[6] Vanpooling has a much lower mode share, at 0.3 percent; it has been most effective in niche markets serving relatively long-distance commuters to large employers. One study estimated the theoretical market potential of vanpooling, based on the number of employees working for larger employers and commuting longer distances, to be about five percent.[7]

One study indicated that ridesharing programs can attract five to 15 percent of metro area commute trips if they offer marketing information only, and up to 30 percent if they offer financial incentives (e.g., parking cash out programs, vanpool subsidies) as well.[8] Other studies have found more limited impacts. An early evaluation of over 100 Federally funded carpool demonstration projects found that approximately one out of six employees exposed to a program submitted applications for carpool assistance; of these, 16 percent were influenced to join or expand carpools as a result of carpool matching efforts – representing just under one percent of total areawide employment. Including others who were influenced by marketing and promotion campaigns, 2.8 percent of the areawide commuter population in six evaluated areas had formed or expanded rideshare arrangements.[9]

Energy Savings and Environmental Benefits

Carpooling can reduce commuters' fuel use by nearly one half compared to two commuters driving alone, although there will be some loss in benefits if one traveler must go out of their way to pick up the other. Vanpooling is estimated to consume the least amount of energy per passenger of any motorized form of transportation, and can lead to substantial reductions in fuel consumption.[10] The State of Connecticut's vanpool program registered over 3,000 commuters in 2006, 68 percent of whom were new to carpooling and transit. The state estimates that over 2.8 million passenger miles were reduced, resulting in the reduction of 1,250 tons of GHG emissions or 0.42 tons per vanpooler.[11] A Chicago vanpool program consisting of 252 vanpools was estimated to have reduced VMT by nearly 120,000 miles per day, NOx by 0.16 tons per day, and carbon monoxide by 0.64 tons per day.[12]

Economics

The cost of adding another passenger to a car is minimal since an SOV has seats that would otherwise be unoccupied. Ridesharing tends to have lower costs per vehicle mile than transit since it does not require paid operators and empty backhauls. Nonmonetary costs to passengers include the additional travel and wait time needed to coordinate with ridesharing partners as well as schedule inflexibility and loss of privacy.[13] A 1994 literature review found the administrative costs of areawide ridematching programs to be small, resulting in a cost-effectiveness of $0.60 per vehicle round-trip avoided.[14]

Vanpool costs include purchase and operating costs for the vehicle as well as administrative expenses. Costs are offset by vehicle operating cost savings to individuals, meaning that vanpool programs can cover most, if not all, of their costs through subscription fees.[15] The price of vanpool fares may have a significant impact on attracting participants. One study showed that a one dollar increase in the price of vanpool fares can be expected to result in a three to 14 percent reduction in vanpool ridership, while a 10 percent decrease in fares will increase the odds of commuters using vanpools by six to 13 percent.[16] Another indicated that a 10 percent reduction in vanpool fares can be expected to increase ridership by 15 percent.[17]

Joining a ridesharing program for work-related commutes and using transit or carsharing (see strategy T.2.5 Carsharing) for nonwork-related travel may allow a family to relinquish ownership of one or more family vehicles. A 1981 survey of vanpool participants in Norfolk, Virginia indicated that 28 percent of passengers and 29 percent of drivers deferred the purchase of a new vehicle due to their vanpool use.[18] Individuals who join ridesharing programs in lieu of private vehicle ownership can experience significant savings on depreciation, financing, registration, insurance, parking and maintenance. The following table shows average yearly fixed ownership costs for a small sedan (e.g., Honda Civic, Ford Focus) and a sport utility vehicle (e.g., Ford Explorer, Toyota 4Runner).[19]

Ownership Cost	**Cost/year (compact)**	**Cost/year (SUV)**
Insurance	$949	$888
License, Registration and Taxes	$410	$715
Depreciation (15,000 miles/year)	$2,332	$4,327
Finance charges	$541	$1,000
Total	**$4,232**	**$6,930**

The costs of administering a rideshare program consist largely of administrative expenses, and have been estimated at around $3 per user.[20] Vanpools are one of the most cost effective ways to commute.[21] Typical vanpool vans cost from $1,000 to $1,250 per month to operate.[22]

Programs in Operation

The Transportation Commissions in **Los Angeles, Orange, Ventura, San Bernardino and Riverside Counties** collectively offer a free ride matching service, CommuteSmart.info. The web site offers a database of thousands of prospective carpool and vanpool partners, and provides information on the guaranteed ride home program, traffic updates, and incentive programs for participating in ridesharing in the five county area. The web site offers a carpool lane map and park-and-ride locations, in addition to a transit planning feature. On-line at http://commutesmart.info/index.asp.

The **San Diego** Association of Governments offers RideLink, an on-line commuter resource on vanpools and carpools in San Diego County, as well as transit, nonmotorized travel, and telework options. The site's iCommute database contains commute origin and destination information for thousands of county commuters, and offers a ride matching service for potential carpooling, vanpooling, or biking partners. The site also offers information on collecting the available $400 subsidy for new vanpools, as well as other potential reward programs. On-line at http://www.ridelink.org.

The **San Francisco** Bay Area's metropolitan planning organization, Metropolitan Transportation Commission (MTC), offers a detailed on-line travel resource for bay area commuters. In addition to a customized ridematch service, 511.org offers up-to-the-minute traffic information and customized traffic updates that can be sent directly to cell phones or other mobile devices for route planning purposes. New Bay Area carpools are eligible for up to $100 in subsidies, while new vanpools are eligible for up to $900. Registered ridesharers can participate in a commute diary to receive cash and gas voucher rewards based on ridesharing frequency and mileage. On-line at http://www.511.org.

Resources

Vanpooling – A Handbook to Help You Set Up a Program at Your Company is a manual prepared by Commuter Transportation Services that provides program design and implementation procedures targeted at employee transportation coordinators. It discusses the administration of carpooling efforts and leasing of vanpool vehicles among other details. Available on-line at http://ntl.bts.gov/DOCS/NPO.html.

Implementing Effective Travel Demand Management Measures, published by Comsis Corporation and the Institute of Transportation Engineers in 1993, provides a comprehensive review of vanpooling as a strategy, its market and cost effectiveness, and estimates of travel impact potential. Available on-line at http://ntl.bts.gov/DOCS/474.html

Transit Cooperative Research Program (TCRP) Report 95 Traveler Response to Transportation System Changes Chapter 5: Vanpools and Buspools, published by the Federal Transit Administration in 2005, is a resource on the effect of vanpool program changes on program participation and other impacts. Available on-line at http://onlinepubs.trb.org/Onlinepubs/tcrp/tcrp_rpt_95c5.pdf.

The Victoria Transport Policy Institute's *Transportation Demand Management Encyclopedia* offers a detailed on-line resource on ridesharing implementation, cost-benefit analyses and selected case studies: *Ridesharing: Carpooling and Vanpooling*. Available on-line at http://www.vtpi.org/tdm/tdm34.htm.

Related Strategies

L.2.2	Parking Supply Management
T.1.3	Park-and-Ride Lots
T.2.1	Transportation Demand Management Programs
T.2.5	Carsharing

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CARSHARING

When faced with the choice of traveling by transit or by car, vehicle owners often find that the cost of using transit is equal to or greater than the daily out-of-pocket cost of driving to a destination. However, the full cost of driving is much higher and hidden in the cost of buying the car, depreciation, financing, registration, insurance, residential parking and maintenance. These fixed costs of owning a vehicle can be quite substantial, approaching 80 percent of total ownership costs1 and roughly one fifth of total household expenditures.2 Clarifying the economics of automobile ownership versus alternative travel choices can be of great financial benefit to a household, leading to increased savings, lower vehicle miles traveled (VMT) and higher transit use.

Carsharing refers to a unique automobile rental service designed to serve as a substitute to private vehicle ownership. As opposed to traditional car rental services, carsharing makes occasional vehicle use convenient and affordable, and provides an incentive to minimize driving by charging higher variable rates and very low fixed rates. Carsharing for many subscribers makes it feasible to own one car instead of two, or no car instead of one, while conveniently and more affordably meeting travel needs. Similar to guaranteed ride home programs (see strategy T.2.3 Guaranteed Ride Home Programs), carsharing provides commuters with "mobility insurance" – the knowledge that they may take transit or carpool to work without being stranded in the event of an emergency.

Carsharing vehicles in San Francisco.
Photo: Flickr/Frankfarm.

Ideally, carsharing should feature: 1) accessible locations (designated parking located near residential neighborhoods, commercial centers, transit stops and other access points); 2) affordable rates that are suitable for short trips; 3) convenient vehicle access (e.g., through electronic keys or pass codes); and 4) reliable vehicles with frequent availability.[3] Local governments can help attract and expand successful carsharing programs by enacting policies that help achieve these conditions.

General Plan Language Ideas

» The City/County shall encourage private, for-profit community carsharing, including designating parking spaces for car share vehicles in public lots and convenient locations accessible by public transit.

» The City/County shall incorporate carsharing in its ongoing community outreach campaigns, including transportation demand management and greenhouse gas emissions reduction strategies.

» The City/County shall grant zoning exemptions to downtown minimum parking requirements for developments that include access to carsharing services.

» The City/County shall seek a partnership with the carsharing provider to reduce municipal fleet ownership costs for underused vehicles and encourage municipal employees to take part in the carsharing program.

Implementation Ideas

» **Offer start-up grants.** Seed money may be the most valuable contribution local governments can provide to carsharing programs. Most existing shared-use car programs (e.g., Zipcar) have received startup grants (ranging from Federal to municipal) to support the initial investments of for-profit or nonprofit providers.[4] External grants may be sought to support fleet acquisition, start-up administration, finance feasibility studies or other specific purposes. The U.S. Environmental Protection Agency, Federal Transit Administration (FTA) Job Access and Reverse Commute program, FTA Congestion Mitigation Air Quality (CMAQ) Improvement program, and Caltrans' Community Planning Grant program are a few potential sources of carsharing funding.[5]

» **Offer administrative assistance.** Lend unused office or meeting space and provide staff time and technical guidance to potential carsharing partners in need of administrative assistance.

» **Offer designated carsharing spaces at public facilities.** Transit agencies can designate restricted carsharing spaces in or near park-and-ride lots. City/county governments can designate spaces in public parking facilities at key destinations; on-street parking in high-demand may also be offered to promote the visibility of carsharing operations. Roughly two-thirds of shared-use vehicle programs have reported receiving designated parking from public entities.[6]

» **Offer subsidies to private facilities that provide designated carsharing spaces.** Subsidies may be offered to private parking facility operators that designated shared-use vehicle spaces. Roughly three-quarters of existing carsharing programs have benefited from such subsidies.[7]

» **Grant zoning exemptions for carsharing partnerships.** New commercial and residential developments are often subject to minimum parking requirements by local zoning ordinances. Developments offering carsharing access may be granted exemptions on minimum parking requirements. Mixed-use and transit-oriented developments may be particularly suited for designated carsharing requirements (see strategies L.1.1 Smart Growth Development, L.1.2 Land Use Diversity, L.1.3 Transit-Oriented Development, and L.2.2 Parking Supply Management).

» **Assist carsharing operators with marketing campaigns.** Provide carsharing information on web sites and newsletters, distribute materials at employer outreach evens, issue press releases, and add carsharing to transportation demand management (TDM) marketing campaigns.[8]

» **Implement carsharing in conjunction with other TDM and greenhouse gas reduction plans.** Carsharing programs compliment other efforts to reduce vehicle miles traveled (VMT), promote nonmotorized and transit modes, and reduce greenhouse gas emissions. Enacting carsharing programs to expand transit ridership may be particularly beneficial.[9]

» **Partner with carsharing organizations to aid in vehicle reduction programs.** For instance, the city of Portland, Oregon joined with nonprofit CarSharing Portland to link the scrapage fee for the citywide scrap program for cars that fail smog tests to the $500 security deposit required for new CarSharing Portland members.[10]

» **Enroll the city/county as a carsharing member.** A municipal carsharing membership can contribute to the growth of the operator while saving public funds spent on underutilized public fleets. Since most carsharing operators experience peak demand in evening and on weekends, specialized vehicles are often available for municipal use during the workday.[11]

» **Target college campuses and other areas with lower car ownership.** Market carsharing through colleges and universities to inform prospective students of carsharing opportunities and reduce the number of cars on campus. Target destinations with limited parking, such as hospitals and other public facilities not served by transit.

Transportation Benefits

Carsharing programs can increase transit ridership by linking carsharing-equipped transit stops with suburban destinations. Transit can also provide potential customers with access to distant carsharing locations. For individuals who did not previously own a car, carsharing provides easier access to a vehicle, which can induce new vehicle trips. However, this can be seen as a social benefit by providing access to lower-income households that may not otherwise be able to afford a vehicle.[12]

An average of 21 percent of new carsharing members give up their vehicle after joining the program, which results in an estimated net reduction of five to six privately owned vehicles for each carsharing vehicle. Studies have shown that new members report up to 70 percent reductions in new car purchases,[13] although a 2003 study of the San Francisco City CarShare program indicated that only four percent of users avoided purchasing a new car as a result of their carsharing membership.[14] This study and a study of CarSharing Portland suggest that VMT per member declines over time, potentially due to an increased awareness of the real cost of vehicle travel.[15]

According to multiple studies, carsharing programs are more likely to attract individuals who are well-educated, from small households, between the ages of 25 and 45, and have higher than average incomes.[16] A survey of carsharing program members from the United States and Canada revealed that carsharing was usually used for recreation (55 percent of users) and shopping (50 percent) rather than work-related trips (21 percent). Most respondents used carsharing because they had things to carry (48 percent), needed a car to access their destination (38 percent) and had to make multiple stops (26 percent).[17] Members of Philadelphia's nonprofit carsharing program reported that convenience was their most important reason for joining (41 percent), followed by affordability (20 percent), personal freedom (16 percent) and environmental concerns (10 percent).[18]

Energy Savings and Environmental Benefits

The impact of a carsharing program on gasoline consumption and emissions, including greenhouse gas emissions, will depend largely on its ability to reduce VMT, with larger programs having the potential to create more sizeable emissions reductions. In San Francisco, the net change of members' daily workweek VMT fell by 6.5 miles relative to a control group of nonmembers over a two-year period.[19] Members in Arlington, Virginia reported a 43 percent reduction in VMT, or 3,250 miles per year.[20]

Hybrid and electric vehicles, which account for a small but growing proportion of the total U.S. carsharing fleet, may further reduce area emissions. Most carsharing providers maintain a fleet consisting largely of more compact, fuel-efficient cars with a limited number of larger SUVs or pick-up trucks available for special purposes. This can allow members to select the most efficient vehicle for a specific trip purpose.[21] To the extent that older, less fuel-efficient vehicles are given up as individuals join the program, additional emissions reductions may be realized.[22]

"Individuals who join carsharing programs in lieu of private vehicle ownership can experience significant savings on depreciation, financing, registration, insurance, parking and maintenance."

Economics

Individuals who join carsharing programs in lieu of private vehicle ownership can experience significant savings on depreciation, financing, registration, insurance, parking and maintenance. The following table shows average yearly fixed ownership costs for a small sedan (e.g., Honda Civic, Ford Focus) and a sport utility vehicle (e.g., Ford Explorer, Toyota 4Runner).[23]

Ownership Cost	Cost/year (compact)	Cost/year (SUV)
Insurance	$949	$888
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Depreciation (15,000 miles/year)	$2,332	$4,327
Finance charges	$541	$1,000
Total	**$4,232**	**$6,930**

Carsharing shifts the financial burden from fixed costs to variable costs, which provides customers with an incentive to take alternative modes. Carsharing programs typically charge a small monthly or yearly fee along with an hourly fee and/or a per-mile charge. For instance, nonprofit San Francisco City CarShare charges a $10 monthly membership fee, a $5 per hour usage fee, 40 cents per mile, and an optional $40/day rate plus 10 cents per mile.[24] The for-profit provider Zipcar charges $50 annually, a $9 per hour usage fee, and an optional $66/day rate.[25] The threshold for the cost-effectiveness of carsharing has been estimated at 5,000 miles per year – those who drive less than this will likely see cost savings by switching to a carsharing program.[26] Travelers who use alternate modes when they would otherwise have traveled by car may earn additional savings.

Ensuring adequate economies-of-scale is critical to the success of carsharing programs. The greater number of vehicles and locations a program can support, the more convenient and appealing it becomes to potential users. Larger programs can support greater investments in technology such as improved vehicle access, reservations, and billing methods that increase customer convenience. Insurance, a major expense to carsharing providers, can be reduced by a larger fleet size and longer operational history. Larger programs also provide free advertising – studies have shown that 20 percent of program members become aware of the service after seeing a carsharing vehicle in use. Finally, the additional profit gleaned from economies of scale allows larger organizations to offer more affordable rates and discounts to prospective members.[27]

Programs that successfully reduce vehicle ownership in dense urban areas may alleviate residential parking needs and allow businesses to lease fewer spaces.[28] This can result in cost savings for developers, residents, and cities, and can free land that would have been used for parking for open space or new development (see strategy L.2.2 Parking Supply Management).[29] Savings can be substantial in dense urban areas – eliminating parking from a new San Francisco housing development can save an average of $20,000 to $30,000 per space, and over $50,000 in some areas.[30]

Programs in Operation

In 1999, the City of **Berkeley** partnered with City CarShare, to incorporate carsharing in its planning and development process, and to replace municipal fleet vehicles with carsharing vehicles. During the initial phase of City CarShare implementation, the city invested significant time investigating the potential of introducing a carsharing fleet and applying for hybrid vehicle grants, and provided a conference room for City CarShare user orientation. The first year of the program was funded by a parking mitigation payment of $150,000 from a developer who provided 10 fewer parking spaces than required under the city's zoning ordinance. Berkeley replaced 15 city vehicles with four City CarShare vehicles, which are made available to residents on evenings and weekends. The program saved the city tens of thousands of dollars per year in direct expenses. In 2003, the city required a 176-unit apartment building with ground-floor retail to provide up to four parking spaces for carsharing vehicles.[31] http://www.citycarshare.com

The **San Diego Association of Governments (SANDAG)** employed a project manager and associate who spent a total of 350 hours per year assisting in carsharing program administration. This staff time was covered by external funding and was a short-term commitment meant to facilitate the initial stages of the partnership.[32]

The City of **Seattle**, Washington and its transit agency, King County Metro, launched a public-private partnership with the for-profit provider Flexcar in 2000. The City, King County Metro, and the University of Washington conducted market research in preparation for the service. King County Metro viewed Flexcar as part of its travel demand management strategy; it provided funding in exchange for specific implementation requests such as advanced access and reservation technologies, and locating vehicles in specific neighborhoods. Seattle provided designated parking spaces in low-income areas to meet its goal of increasing access for low-income residents, and tied its aged vehicle reduction program to Flexcar membership. The University of Washington partnered with Flexcar to grant discounts to students. U.S. Environmental Protection Agency grants were sought to facilitate the purchase of low-emission vehicles. The first vehicles were located in Capitol Hill, a dense neighborhood with low auto ownership and scarce parking, and the service was soon expanded to downtown, other neighborhoods, and key suburbs. By 2003, the Flexcar Seattle fleet was 50 percent more fuel efficient than the U.S. average.[33] Flexcar merged with Zipcar in 2007. http://www.zipcar.com.

Resources

The Victoria Transport Policy Institute's Transportation Demand Management Encyclopedia offers a detailed on-line resource on carsharing implementation, cost-benefit analyses and selected case studies: *Carsharing: Vehicle Rental Services That Substitute for Private Vehicle Ownership.* Available on-line at http://www.vtpi.org/tdm/tdm7.htm.

Transit Cooperative Research Program (TCRP) Report 108: Car-Sharing: Where and How it Succeeds, published by the Federal Transit Administration in 2005, is a resource on tools for the development and implementation of carsharing programs. It presents the detailed results of a multicity survey of carsharing providers and users, including market analysis, strategies for public-private partnerships and procurement and monitoring techniques. Available on-line at http://www.trb.org/news/blurb_detail.asp?id=5634.

Related Strategies

- L.1.1 Smart Growth Development
- L.1.2 Land Use Diversity
- L.1.3 Transit-Oriented Development
- L.1.4 Design Sites for Pedestrian and Transit Access
- L.2.2 Parking Supply Management
- T.1.3 Park-and-Ride Lots
- T.2.1 Transportation Demand Management Programs
- T.2.4 Ridesharing

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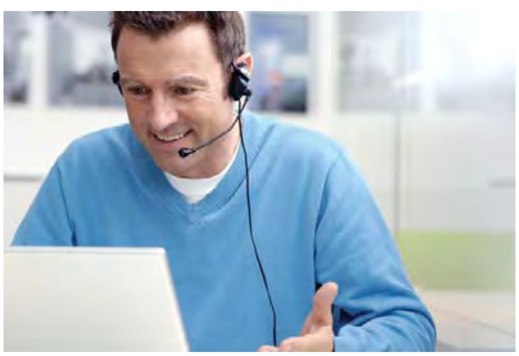
ENERGY AWARE PLANNING GUIDE T.2.6

TELEWORK

Telework substitutes telecommunications such as telephone, fax, e mail, and videoconferencing for vehicle trips, which can save vehicle miles traveled (VMT) and increase productivity. Many work-related trips can be replaced with telecommunication, and some workers are able to eliminate their commute entirely by working at home.

Although managers may be reluctant to allow employees to work outside the office, telework can often add more specificity, structure and discipline to the manager-employee relationship by requiring employees and managers to set specific goals and objectives. Worker productivity has been shown to increase measurably in several studies (see below for details).



Examples of telework options include:

- **Telecommuting. Employees work from home rather than an office.**
- **Satellite Offices. Small work centers away from the central business district can provide special office services to telecommuters. Local or neighborhood telecenters may house telecommuters from more than one employer. Facilities can include copy machines, videoconferencing equipment, secretarial services, meeting rooms, fax machines and other equipment.**
- **Teleconferencing and Videoconferencing. Conference calls and/or live videoconferencing technology can substitute for many in-person meetings.**
- **E-Government Options. Local government services can provide Internet options such as printable forms and on-line databases to make transactions more efficient while reducing the need for non-work-related travel.**

General Plan Language Ideas

- By [date] the City/County shall establish a home-based telework program for City/County employees in order to help reduce employee commute trips
- The City/County shall amend the zoning code to eliminate language that would restrict home-based telework.
- The City/County shall work with the regional planning agency and neighboring cities to prepare a regional assessment of the need for a neighborhood telecenter, and, if necessary, examine potential location(s), the size, funding sources, and other relevant issues.
- The City/County shall facilitate the establishment of satellite offices and local telecenters through zoning code changes, zoning incentives, and discretionary project approval conditions, in areas where they would facilitate reductions in employee commute trips.
- The City/County shall develop incentives and education programs to facilitate private sector telework.
- The City/County shall encourage the use of telecommunications as a substitute for travel for City/County business. Specifically, all employees shall be asked to hold conference calls whenever feasible as an alternative to travel.
- The City/County shall examine the feasibility of establishing a videoconferencing center. The City Manager's or County Administrator's office shall conduct the feasibility study, which will examine costs, potential users (in and outside of the City/County), potential sites, funding, and cost-sharing arrangements.
- As a condition of development, the City/County shall require developers of large-scale commercial and mixed-use residential projects to include tele- and video-conferencing facilities. When not in use by tenants, the facilities must be made available to other entities at a reasonable cost.

Implementation Ideas

- **Establish a home-based telecommuting program for local government employees.** Include training of both employees and managers. In many cases, employees already will have computers or may not need them to perform their work. Otherwise, the city/county should purchase computer equipment, establish special discounts or loan programs so employees may purchase their own computers, loan employees laptop computers, or move existing computers from offices to homes. Allow appropriate employees such as building inspectors to go directly to a site from home in the morning, rather than driving to the office first.
- **Review the local zoning code to eliminate statements that may restrict home-based telework.** For example, language that prohibits home businesses should clearly exempt employees of a company or agency who are telecommuting or information-based workers or entrepreneurs.
- **Develop a list of guidelines on when to use conference calling capabilities versus travel.** Explore the use of public and private teleconferencing centers nearby as a substitute for long distance travel.
- **Assess the need for telework centers.** Work with the regional planning agency, transit agencies, and other local governments to assess the need for telecenters near residential areas. This approach would be particularly effective in "bedroom" communities with a high percentage of workers commuting long distances.
- **Promote the establishment of telecenters.** Based upon the regional assessment, amend the zoning code to allow satellite offices and telecenters in and near residential areas. Work with developers to site centers in new or existing residential developments. Explore all potential sites, including the use of space at schools, libraries, and colleges. Funding may be available through the Congestion Mitigation and Air Qual-

ity Improvement (CMAQ) Program process and other sources. Offer density bonuses or other incentives for commercial developments that include space that would be leased to employers for telecenters. Pool resources with other local governments.

» **Share space with other local governments.** Establish agreements to allow employees of other local governments who live in your community to use your offices and/or equipment and vice versa in order to facilitate telework. For example, employees of one city could receive or send faxes at the offices of the city where they live on days they are telecommuting from home.

» **Organize forums and workshops for local employers to explain the benefits of telework.**

» **Make sure employers subject to a trip reduction ordinance (TRO) receive credit for telecommuting employees.** For example, if the TRO requires employers to meet an average vehicle ridership (AVR) target generally calculated by dividing the number of workers by the number of vehicles arriving at work, employees who telecommute should be included in the numerator, but not the denominator.

Transportation and Energy Benefits

The likelihood of employees to adopt telework depends on several factors, including job type, telecommunications service quality, employer support, individual preferences, and available incentives and promotions.[1] Telework becomes a more attractive option the farther away a commuter lives; this means VMT reductions can be significant. For example, if 10 percent of vehicle trips are reduced via a telework program, VMT may drop 15 percent if the trips eliminated are longer distance commutes.[2]

A study of the State of California's telecommuting pilot program in the early 1990s found that participating employees reduced work trips by over 40 percent (approximately 366 miles each month).[3] Using these data, each telecommuter saves about 230 gallons of gasoline per year if the telecommuter normally drives alone to work.[4]

When all trips are included, telecommuters also reduced trips per day by about 20 percent. Telecommuting did not lead to an increase in nonwork trips and household members did not increase car use even if an additional car became available as a result of telecommuting.

Telework options may have unintended consequences as well. For instance, vehicles not used for commuting may be used by other household members or to run errands that would otherwise have been run during a commute. In addition, employees may use telework options as an incentive to move farther from their worksite, which can increase urban sprawl and nonwork-related VMT. Still, a 1996 survey of 400 teleworkers indicated that each daily telecommute results in a VMT reduction of 30 miles, and that if 10 percent of the workforce were to telecommute on any given day, total VMT for that day would decline by four percent.[5] A 2000 study estimated that 6.1 percent of California workers telecommute an average of 1.2 days per week, which eliminates 1.1 percent of total statewide VMT.[6]

Environmental Benefits

A study of neighborhood telework centers in the Seattle area found they may have the potential to reduce VMT considerably, but may provide smaller emissions reductions due to heavy emissions produced in "cold starts."[7] Work trips usually involve starting a cold engine, which emits a large amount of pollutants. For example, a two-mile round trip emits only about 65 percent fewer grams of pollutants than a 20-mile round trip, even though it is 90 percent shorter. About 80 percent of the emissions in the two-mile trip come from starting and turning off the engine.[8] Emission reductions per telecommuter per day is greatest for a home-based program and telecenter programs accessed by walking, bicycling or transit without motor vehicle use. However, telecenters can contribute to emission reductions in cases where home-based telework is not possible, since the centers may attract a large number of participants who would otherwise drive longer distances.

An analysis of the California state telecommuting pilot project found that vehicle emissions for telecommuters dropped 63 to 73 percent on telecommuting days.[9]

Economics

Evaluation of the costs and benefits of the State of California telecommuting pilot project with over 200 telecommuters found that the program broke even within three years (after startup costs) and that direct benefits outweighed costs by a five to one margin. Direct costs included training (about $300 per telecommuter-supervisor pair), phone costs (estimated at $30 per month per telecommuter), computers and maintenance and administration. Few employees needed extra phone lines or computers.[10]

Direct benefits included increased employee effectiveness (seven to 10 percent increase), decreased sick leave (10 to 20 percent fewer days), decreased turnover, reduced parking requirements and office space savings. Nearly 20 percent of the telecommuters stated that telecommuting had been a moderate to decisive factor in their decision to remain in their job.[11] The California telecommuting pilot program measured productivity increases of 10 to 30 percent, and a 1997 survey of Fortune 1000 telemanagers reveled that 58 percent saw productivity increases as a result of telework programs.[12] If unoccupied or underoccupied desks, workstations and equipment are consolidated as a result of increased telework, employers can save on both equipment and maintenance costs and may save in commercial lease expenses by downsizing office spaces.[13]

Telecommuters save on commute costs. The American Automobile Association estimates the operating costs of a vehicle to be 13.9 to 19.1 cents per mile. With ownership expenses, the cost can range from 35.7 to 85.8 cents per mile, depending upon the car and total miles driven per year. The telecommuters who reduce travel to work by 300 miles per month would save $500 to $690 per year in vehicle operating costs.[14] Telecommuters could also consider avoiding the purchase of a second car, saving thousands more per year. While some telecommuters may end up paying more for utilities, computer equipment, or space, these costs may be offset by reduced commute costs.

Programs in Operation

Ridelink, a transportation assistance program offered by the **San Diego** Association of Governments (SANDAG), offers a variety of services to employers interested in implementing telework programs. Ridelink provides one-on-one consultant services with telework experts, presentations on telework benefits, and assistance with design and implementation of programs, development of policies and agreements, program evaluation strategies, and training sessions. More information at http://ridelink.org.

The City and County of **San Francisco** launched a pilot telework program between 2004 and 2005 with support from private sector partners SBC Communications and Sun Microsystems. The city implemented new technology developed by Sun Microsystems to maintain security and operability in participants' home offices. In addition, SBC Communications assisted the city in installing DSL upgrades in some participants' homes. A program evaluation concluded the initiative was successful in boosting productivity and reducing vehicle miles traveled. It has since been expanded.[15]

The **State of California** Department of Personnel Administration offers a Telework Policy for state civil service employees. Individual telework plans are submitted to an employee's immediate supervisor and division chief with specific guidelines agreed to by all parties. Available on-line at http://www.dgs.ca.gov/Telework/TeleworkPolicy.htm.

Resources

The State of California Department of General Services publishes an extensive on-line resource of state guidelines, sample policies, and funding sources. Available at http://www.dgs.ca.gov/Telework/Resources.htm.

The Telework Toolkit, created by the Kitsap Regional Coordinating Council and funded by the Washington State Department of Transportation, provides employers and employees with telework options, resources, and technology possibilities, as well as case studies, guidance, and sample telework agreements. Available at http://www.teleworktoolkit.com.

The Telework Coalition is a Washington, D.C.-based organization that provides an information clearinghouse for the promotion of telework in the United States. More information available on-line at http://www.telcoa.org.

Related Strategies

T.1.1	Transportation Demand Management Programs
T.1.2	Transportation Management Associations
T.2.7	Alternative Work Schedules

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ALTERNATIVE WORK SCHEDULES

Alternative work schedules can reduce traffic congestion and energy consumption in two ways: shifting commuters out of the peak travel periods, and eliminating commute trips. With "compressed work weeks," employees work more than eight hours each day in order to take an extra day off, thereby reducing vehicle miles traveled (VMT). For example, on a 9/80 schedule employees work nine hours four days each week, eight hours one day every other week, and are off one day every other week (usually Monday or Friday). On a 4/40 schedule, employees work four 10-hour days per week.

"Flex-time" scheduling allows workers to set their schedules depending upon their needs, with the exception of certain core hours during which they must be at work. Flex-time programs usually reduce the number of workers commuting during the peak travel period. However, there is conflicting evidence whether this encourages or discourages the use of transit, carpools, and vanpools.

"Staggered shifts" can be used to reduce peak congestion by staggering the start and end times of employee work days. Because employees' schedules will vary and are not flexible, ridesharing arrangements may be more difficult.

General Plan Language Ideas

» The City/County will encourage all employers to allow employees to work alternative schedules, such as 4/40 and 9/80 work weeks.

» The City/County shall require all employers to submit annual "employee trip reduction plans," including alternative work schedule options for businesses with 50 employees or more.

» The City/County shall establish an alternative work schedule program that allows its own employees to work on a compressed work week schedule.

Implementation Ideas

» **Implement a compressed work week program for city/county employees.** Allow municipal employees to work 9/80 and/or 4/40 schedules.

» **Promote the city/county alternative work schedule program as a model to local employers.**

» **Make transit schedules compatible.** Work with the transit agency to expand transit service for people working 9- or 10-hour days, if funding is available.

Transportation and Energy Benefits

Compressed work weeks eliminate some commute trips altogether, which can result in a major reduction in energy use. Studies have found that compressed work weeks can reduce vehicle commutes by seven to 10 percent,[1] and that they can reduce employees' total commute time considerably.[2] Other studies have indicated that compressed work weeks result in only modest VMT reductions because many participants make additional nonwork-related trips on their day off.[3] There is evidence that additional travel on days at home can comprise roughly 25 percent of the total reduction in work-related trips. One study estimates an additional six miles of nonwork-related travel for each day spent at home rather than working.[4] Home energy consumption will increase on days spent at home. Compressed work weeks may also discourage employees from taking part in rideshare programs due to irregular work hours.

Flex-time and staggered work hours reduce congestion by shifting trips out of the peak period. This can also lead to reductions in energy use. For example, one study indicated that fuel consumption increases 30 percent when average speeds drop from 30 to 20 mph. A drop from 30 to 10 mph can result in a 100 percent increase in fuel use.[5] Employees with flex-time have been found to save an average of seven minutes per day in time spent commuting.[6]

For each employee on a 9/80 schedule, about 25 commute trips (10 percent) would be eliminated over the year, conserving 26 to 40 gallons of gasoline. About 50 commute trips (20 percent), or 53 to 80 gallons of gasoline, would be eliminated for each employee on a 4/40 schedule.[7] These savings may be reduced by nonwork vehicle travel on days off.

A 1980 study of 7,000 Federal employees on compressed work weeks in Denver found that total weekly travel for households with employees on compressed work weeks was almost 16 percent less than other Federal employee households. Approximately 35 percent of this was due to reductions in nonwork-related travel. This may be because employees could be more efficient and combine nonwork trips on their day off. About one-half of the participating employees were on 9/80 schedules and one-half were on 4/40 schedules.[8]

The table below provides the overall reduction in commute travel with varying levels of employee participation in either of the two compressed work week schedules. The figures do not include decreased nonwork travel, which may be conservative, based on the Denver survey. Also, note that the table does not include the additional energy efficiency benefits of improving traffic flow by reducing the number of peak period commuters.

Reduction in Total Employee Commute Trips[9]		
Percent Employee Participation	**9/80**	**4/40**
20	2%	4%
30	3%	6%
40	4%	8%
50	5%	10%
60	6%	12%
70	7%	14%
80	8%	16%
90	9%	18%

Environmental Benefits

Reductions in auto emissions associated with commuting may be similar to the reductions in commute trips shown in the table. The Denver study estimated that hydrocarbon and carbon monoxide emissions were about 16 percent less for employees with compressed work weeks.[10] Relieving congestion during peak periods will reduce emissions further. The vast majority of the trips eliminated by switching to compressed work weeks occur on Friday or Monday. If these are particularly congested days in an area, the impact on local air quality may be significant. Programs may also emphasize the benefits of taking Tuesday, Wednesday or Thursday off.

Economics

Implementing and administering an alternate work schedule program will impose some costs on employers. Productivity may be more difficult to monitor for those employees taking part in flex-time or compressed work weeks. Furthermore, alternative work schedules may reduce staff interaction and create difficulties in scheduling meetings. If compressed work weeks require the business to extend its hours, additional expenses (for example, utilities) may be incurred. Due to strict state overtime laws, wage employees who take part in a compressed work week may accrue overtime benefits at the expense of the employer.

Employer benefits of compressed work weeks include: reduced absenteeism and tardiness; reduced turnover; fewer sick days, increased job satisfaction, and lower overtime costs. For example, as a result of flextime schedules implemented prior to 1984, the city of Berkeley estimated that it reduced overtime costs by $18,000 and sick leave costs by $26,000 annually.[11] Longer or better office coverage may be possible with the longer days and rotating days off. Compressed work weeks also can be a low-cost fringe benefit and recruiting advantage. A survey of Los Angeles commuters found that 68 percent of commuters were interested in flexible work hours and 53 percent would participate in a compressed work week.[12] Flex-time and compressed work weeks are almost sure to benefit participating employees since they are generally optional features; employees who take part are almost always better off, or they would not choose to participate.[13]

Programs in Operation

The City of **Los Angeles** has a Commuter Services Program that encourages ride sharing, public transit use, telework, and bicycling. Its Alternative Work Schedule program allows workers to choose from three compressed workweek schedules. The Commuter Services Office has estimated that the program has resulted in an annual reduction of more than 1.2 million vehicle miles traveled.[14]

The City of **Santa Monica** requires employers of 50 or more employees to submit an annual commute trip reduction plan. Employers must survey employees to establish commute patterns for the morning and evening and use the information to submit a plan for reducing average vehicle ridership to 1.5 employees per vehicle. City Hall employees and police officers are offered 9/80 compressed work week opportunities.[15]

The City of **Santa Clarita** currently employs a 9/80 work week for most employees.[16]

Resources

The U.S. Office of Personnel Management offers the *Handbook on Alternative Work Schedules*, a guide for Federal agencies on workplace alternative work schedule policies. The handbook is available on-line at http://www.opm.gov/oca/aws.

The Victoria Transport Policy Institute's *Transportation Demand Management (TDM) Encyclopedia* offers a detailed on-line resource on alternative work schedules, best practices, and selected case studies: Alternative Work Schedules: Flextime, Compressed Work Week, Staggered Shifts. Available on-line at http://www.vtpi.org/tdm/tdm15.htm.

Related Strategies

- T.2.1 Transportation Demand Management Programs
- T.2.6 Telework

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TRAFFIC SIGNAL TIMING

Vehicles are most efficient when traveling at steady speeds. Stop-and-go driving and idling resulting from poorly timed traffic signals wastes fuel and increases greenhouse gas emissions. Optimizing the timing of existing signals and installing advanced control equipment can significantly reduce traffic congestion (and by association the need to widen roads), fuel use, and vehicle emissions. Intelligent transportation systems (ITS) can be a valuable tool for optimizing traffic signal performance. Providing signal priority for transit vehicles and accommodating bicyclists and pedestrians at signalized intersections can encourage the use of alternative modes of transportation.

General Plan Language Ideas

» Traffic signals shall be timed to improve fuel efficiency and reduce traffic congestion and evaluated for retiming every three to five years.

» Traffic signals shall be timed to allow pedestrians and bicyclists sufficient time to safely cross intersections.

» By [date], Public Works shall evaluate the feasibility of a computerized traffic signal system. If energy savings are significant, the Department shall develop a plan to implement such a system This may include requiring developers to install equipment in new developments and/or assessing traffic impact fees to fund a system for impacted signals.

Implementation Ideas

» **Schedule regular signal timing maintenance.** Rather than waiting to respond to complaints as they arise, schedule regular preventive signal maintenance to identify and resolve timing issues. Routine updates should take place at least every three to five years.

» **Optimize timing for special events and seasonal fluctuations.** Holiday shopping, sporting events, fairs and other events change traffic patterns and create significant delays. Consider changing signal timing during these times.

» **Install additional equipment to improve timing.** Equipment could include traffic-actuated signals, interconnected signals and/or computerized master controls.

» **Require new intersection controls as a California Environmental Quality Act (CEQA) mitigation measure for large projects.**

» **Improve pedestrian signal phases.** Providing pedestrians with longer signal phases at signalized intersections and offering leading pedestrian intervals, passive pedestrian detection, and/or pedestrian phase countdown displays can improve pedestrian visibility and security. This enhances the comfort and safety of walking, making it a more viable alternative to driving.

» **Coordinate signal timing and signal control systems with neighboring jurisdictions** and with state or regional agencies having jurisdiction over any signals within the city/county.

» **Provide traffic signal priority to transit vehicles.**

Transportation Benefits

Cities participating in California's Fuel Efficient Traffic Signal Management (FETSIM) Program reduced fuel consumption by an average of 7.8 percent, reduced travel time by 7.4 to 11.4 percent, decreased delay by 16.5 to 24.9 percent, and reduced stops by 17.0 to 27.0 percent.[1] In a 2001 study, the City of Los Angeles Department of Transportation estimated that its Adaptive Traffic Control System (ATCS), which automatically adjusts signal timing at 375 intersections, reduced travel time by 12.7 percent, decreased average stops by 31 percent, and reduced average delay by 21.4 percent.[2]

Reducing travel times for automobiles may encourage more travel, though the increase is unlikely to offset the savings made through improved efficiency. Providing transit vehicles with signal priority and accommodating pedestrians and bicyclists at signalized intersections can reduce vehicle miles traveled by making other modes more attractive.

Energy Savings and Environmental Benefits

The California Air Resources Board estimates that a traffic signal coordination program that increases average corridor speed from 28 mph to 33 mph on a corridor that handles 38,400 vehicle trips per day can be expected to reduce volatile organic compounds (VOCs) by 1,057 pounds per year and nitrogen oxide (NOx) by 793 pounds per year. VOCs and NOx are reduced as traffic speeds increase up to about 36 miles per hour. Speeds in excess of this level begin to increase NOx emissions and also discourage walking and bicycling.[3] Signal timing that increases traffic speeds to the detriment of overall performance or that offers vehicle travel benefits can be harmful to air quality.

Traffic signal timing can reduce fuel consumption and greenhouse gas emissions. For every hour of vehicle delay reduced, 0.62 gallons of fuel are saved by autos and 1.93 gallons are saved by large trucks (source: see endnote 4). However, if vehicle speeds are too high in the corridor, pedestrians and bicyclist travel may be discouraged.

Traffic signal timing and coordination can also reduce fuel consumption and greenhouse gas emissions. Based on work done for the Federal Highway Administration, for every hour of vehicle delay reduced, 0.62 gallons of fuel are saved by autos and 1.93 gallons are saved by large trucks.[4] The Institute of Transportation Engineers estimates that comprehensive retiming of traffic signals can reduce fuel consumption by six to nine percent.[5] A study in Portland, Oregon estimated that approximately 50 metric tons of CO2 were saved each year per traffic signal retimed in the city.[6]

Economics

According to the Institute of Transportation Engineers (ITE), updating signal timing averages less than $3,000 per intersection.[7] A 2006 study indicated that the average cost of retiming signals in the nine-county San Francisco Bay Area was $2,400 per intersection.[8] ITE has estimated that the benefits of retiming traffic signals outweigh the costs by over 40 to 1. Cities that participated in the FETSIM program between 1983 and 1993 spent an average of

$1,091 per signal for retiming. Benefits to residents and businesses from reduced fuel, vehicle wear and tear, and time were estimated to be over 17 times the cost.[9]

Programs in Operation

Between 1999 and 2001, the city of **Los Angeles** Department of Transportation deployed an Adaptive Traffic Control System (ATCS), which automatically adjusts signal timing at 375 intersections. The ATCS collects and analyzes extensive detector data to determine real-time traffic demand, control cycle lengths, and phase splits. A 2001 study indicated that the ATCS reduced travel time by 12.7 percent, decreased average stops by 31.0 percent, and reduced average delay by 21.4 percent in affected corridors.[10]

The City of **Fresno** teamed with neighboring municipalities and Fresno County to lay the foundation for an ITS-based coordinated traffic management system. The Advanced Traffic Management System (ATMS) connected the city's new Traffic Operations Center to a fiber optic network, connecting key arterial roads and expressways for an efficient citywide traffic coordination system. In addition to improving traffic flows and reducing congestion, the network of controllers, cameras and radar systems relay "real time" traffic or accident information to Transportation, Transit, Fire, and Emergency Services that assess the incident and dispatch the appropriate response. As of 2008, ATMS interconnects approximately 65 traffic signals along key arterials and parts of downtown Fresno. The Blackstone and Herndon arterial avenues are now synchronized with models indicating travel time reductions of up to 18 percent, fuel savings of 1.35 million gallons annually, and emission reductions of 300 Metric Tons (MT) of Carbon Monoxide, 60 MT of NOx, and 75 MT of volatile organic compounds.[11]

The **Metropolitan Transportation Commission (MTC),** which coordinates regional transportation for the nine-county San Francisco Bay Area, formed its Regional Signal Timing Program (RSTP) in 2003. Through the RSTP, MTC retains consultants to assist in developing and implementing new time-of-day signal coordination plans for weekday peak periods. Of the 7,000 signals in the Bay Area, approximately one-half operate as part of a coordinated system. The RSTP calls for the retiming of the coordinated signals at least once every five years. In 2005, 449 signals were retimed at a cost of $1,076,000. The benefits of these signal adjustments were estimated at 39 times that investment.[12]

The **Salt Lake City** CommuterLink Advanced Transportation Management System (ATMS) was developed so that operators in the Utah DOT Traffic Operations Center (TOC) could monitor and manage freeway and arterial traffic flow at 600 intersections in the Salt Lake Valley. The capital cost of the ATMS was approximately $106 million. Annual maintenance cost was $377,800 and annual operational cost was $2.3 million. Based on the capital cost and estimated life of the system, the annual capital cost was estimated at $8 million, for an annual total of $10.7 million in relative annual costs. ATMS resulted in significant delay reductions, a 36 percent decrease in peak hour delay on freeways as a result of eight-second freeway ramp meters. The overall annual benefits of the system were estimated at $179 million yielding a benefit-to-cost ratio of 16.7.[13]

Resources

The *Traffic Signal Timing Manual,* prepared for the Federal Highway Administration, serves as a comprehensive guide to traffic signal timing principles, practices, and procedures. It describes the relationship between traffic signal timing and transportation policy and addresses maintenance and operations of traffic signals. It represents a synthesis of traffic signal timing concepts and their application and focuses on the use of detection, related timing parameters, and resulting effects to users at the intersection. It discusses advanced topics briefly to raise awareness related to their use and application. Available on-line at http://www.signaltiming.com.

Successful Traffic Signal System Procurement Techniques, prepared for the Federal Highway Administration in 2002, outlines processes that are supportive of successful traffic signal system procurements based on interviews of nine agencies across the United States that have extensive experience in traffic signal system procurement. It addresses equipment as well as software and system procurements. http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13611.html.

A Toolbox for Alleviating Traffic Congestion and Enhancing Mobility, published by The Institute for Transportation Engineers, offers a comprehensive summary of tools that can be used to help alleviate urban traffic congestion, including signal coordination. http://drusilla.hsrc.unc.edu/cms/downloads/Toolbox_AlleviateCongestion1997.pdf.

Related Strategies

L.3.1 Complete Streets and Street Design

T.1.2 Increased Transit Service and Improved Travel Time

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CALIFORNIA ENERGY COMMISSION

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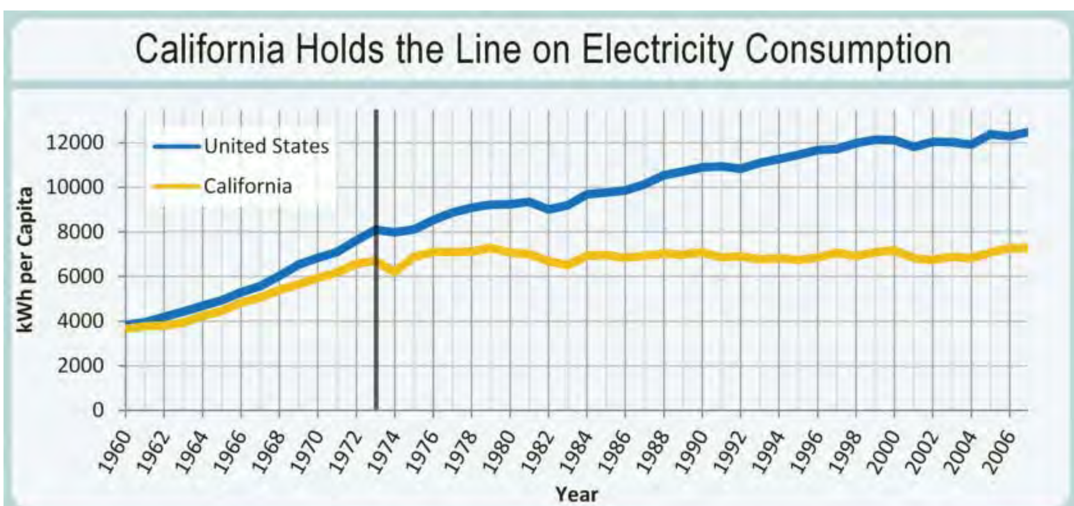
BUILDING STRATEGIES

California has the lowest per capita electricity use in the nation. Over the last thirty years, California's energy use per capita has changed very little while per capita electricity consumption increased by 50 percent in the United States as a whole. These successes have been due in part to California's aggressive efforts to curb energy use from buildings and appliances,[1] especially through energy-efficiency measures. California's building and appliance efficiency standards have saved more than $56 billion in electricity and natural gas costs since 1978.[2]

Recently the state has put an even greater emphasis on energy efficiency. In 2003 three state agencies[3] published an energy action plan emphasizing energy efficiency measures. In 2008, the California Public Utility Commission published a *Long-Term Energy Efficiency Strategic Plan* with input from over 500 individuals and organizations across the state. The plan emphasizes four "Big Bold" strategies as cornerstones for significant energy savings with widespread benefit for all Californians. It sets the foundation for transforming energy patterns to make energy efficiency of way of life and "business as usual" in California and also provides the leadership to change how buildings will be built nationally.

Despite these successes, there still is room for improved building efficiency, especially at the city and county level. This section lists seven strategies local governments can employ to improve building efficiency, including better enforcement of building energy standards, going beyond building energy standards, and retrofitting residential and commercial buildings.



Graphic: California Energy Commission.

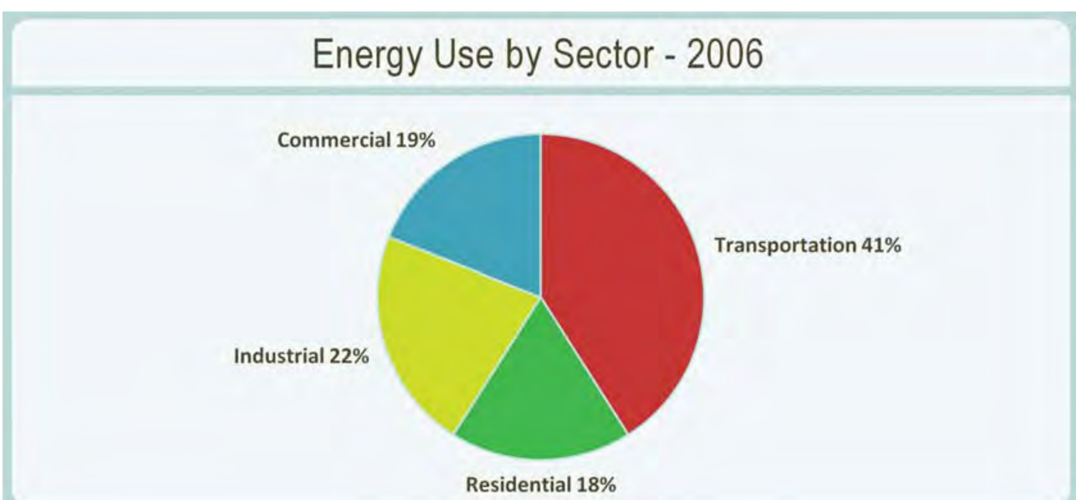
Key Facts – Energy Use and Buildings

- » Nontransportation sources represent about 59 percent of all energy used in California. Most of this energy is used in buildings. The largest sector is industrial (22 percent), followed by commercial (19 percent), and residential (18 percent).[4]
- » The residential sector uses 32 percent of electricity and 22 percent of natural gas consumed in California. Space and water heating account for 88 percent of this natural gas consumption. While the number of households in the state has nearly doubled since 1970, the per household consumption of natural gas has dropped by more than 36 percent as a result of building and appliance efficiency standards.[5] However, the population of California's inland areas (the San Joaquin Valley, Inland Empire, and Sacramento Valley) is growing fast, and will be home to 40 percent of the State's population by 2040. This population growth in hotter inland areas will increase summer peak electricity demand as increasing air conditioning use reduces the system's efficiency.[6]
- » The commercial sector uses 37 percent of the electricity and 10 percent of the natural gas consumed in California.[7] The primary electric end uses are interior lighting (29 percent), cooling (15 percent), refrigeration (13 percent), and ventilation (12 percent). The primary natural gas end uses are for space heating (36 percent), water heating (32 percent), and cooking (23 percent).[8]

The California Public Utility Commission's "Long-Term Energy Efficiency Strategic Plan" includes four "Big Bold" strategies for significant energy savings:

1. **All new residential construction in California will be zero net energy by 2020, i.e., they will consume no more energy than they produce on an annual basis;**
2. **All new commercial construction in California will be zero net energy by 2030;**
3. **The Heating, Ventilation, and Air Conditioning (HVAC) industry will be reshaped to ensure optimal equipment performance; and**
4. **All eligible low-income homes will be energy-efficient by 2020.**

- » The industrial sector uses 16 percent of the electricity and 23 percent of the natural gas consumed in California.[9]
- » Energy efficiency programs that provide incentives to replace inefficient appliances with more efficient ones can generate immediate savings, but they may not be long lasting. If the appliance (such as a washing machine or compact fluorescent light bulb) is replaced with a less efficient one when it wears out, the savings are only temporary. Longer lasting savings come from building and appliance standards that continue to improve efficiency over time.



Graphic: California Energy Commission.

Building Strategies

The following list includes the building planning opportunity summaries included in the Guide. Strategies that appear in other sections of the Guide, but that also reduce building energy consumption, appear in italics.

B.1.1 Improve Enforcement of Building Energy Standards
B.1.2 Going Beyond State Building Energy Standards
B.1.3 Solar Energy
B.1.4 Retrofitting Residences
B.1.5 Retrofitting Commercial Buildings
B.1.6 Efficient Lighting
B.1.7 Shade Trees
C.1.1 Community-wide Energy Programs
C.1.2 Community Energy District Financing
C.2.1 Renewable Energy Resources
C.2.2 Distributed Generation
L.1.6 Diverse and Compact Housing
L.2.1 Street Widths and Pavement
L.2.2 Street Trees
W.2.1 Efficient Wastewater Treatment

The Energy Commission has adopted standards for these appliances:

- **Refrigerators;**
- **Room and central air conditioners**
- **Evaporative coolers and fans;**
- **Space heaters;**
- **Water heaters;**
- **Plumbing fittings and fixtures**
- **Fluorescent lamp ballasts;**
- **Lamps;**
- **Emergency lighting;**
- **Traffic signals;**
- **Luminaires and torchieres;**
- **Pool heaters and pumps;**
- **Dishwashers;**
- **Clothes washers and dryers**
- **Food service equipment;**
- **Electric motors;**
- **Low voltage transformers; and**
- **Power supplies for electronic equipment.**

To view the State appliance standards, visit www.energy.ca.gov/appliances.

Endnotes

1. CEC. 2007. *2007 Integrated Energy Policy Report.* Sacramento: California Energy Commission. p. 2. http://www.energy.ca.gov/2007_energypolicy/index.html.
2. Wong, Solomon. 2005. *Title 24 Energy Efficiency Standards.* Sacramento: California Energy Commission. p. 2. http://extension.ucdavis.edu/unit/green_building_and_sustainability/pdf/resources/title_24.pdf.
3. CEC. 2007. p. 22.
4. Ibid. pp. 25-26.
5. Ibid. p. 35.
6. Ibid. pp. 25 and 167.
7. CEC. 2006. *California Commercial End Use Survey.* Sacramento: California Energy Commission. http://www.energy.ca.gov/2006publications/CEC-400-2006-005/CEC-400-2006-9005.PDF, p. 7.
8. CEC. 2007. pp. 25 and 167.

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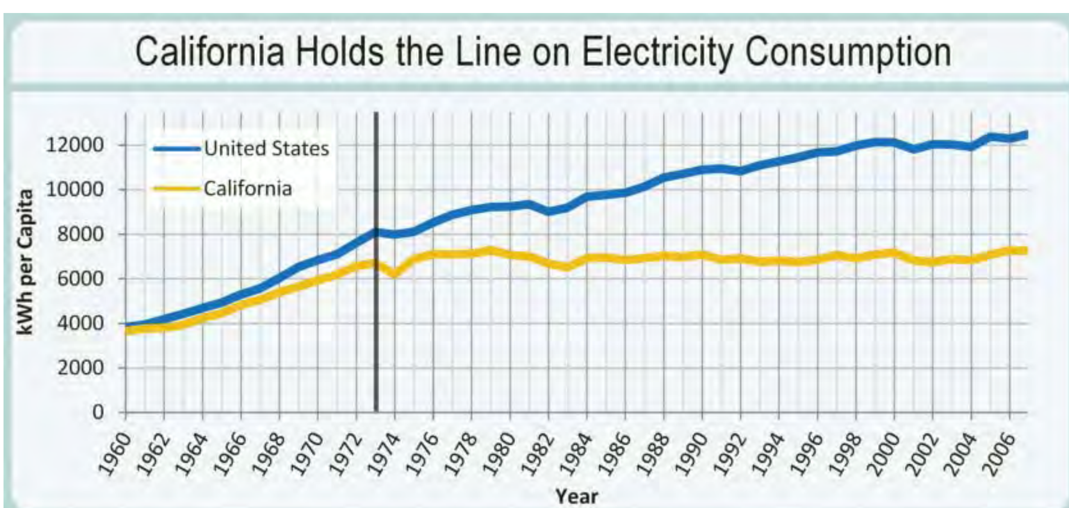
CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

To reduce energy consumption from buildings, the California Energy Commission (Energy Commission), under direction from the Warren-Alquist Act, adopts and regularly updates energy efficiency standards for new building construction and alterations to existing buildings. The Building Energy Efficiency Standards (Standards) appear in Title 24, Part 6 of the California Code of Regulations, along with other building code regulations. The Standards are continually revised about every three years.

The Energy Commission's Standards establish two compliance approaches: performance and prescriptive. Under both approaches, buildings must include a core set of mandatory efficiency measures. With the performance approach, however, a building also must be designed to consume no more energy than specified in the applicable energy budget. The building owner decides which measures will be installed to meet the energy budget. Under the prescriptive approach, specific measures must be installed (in addition to the core measures) that the Energy Commission has predetermined will result in the building meeting the energy budget.

The 2008 California Green Building Standards Code (California Code of Regulations Title 24, Part 11) is incorporated into the 2008 revision of the Building Energy Efficiency Standards. The code standardizes practices for reducing the environmental impact of buildings in a variety of ways, from cutting water and electricity consumption to using less resource-intensive building materials. Application of the code is currently voluntary.



Graphic: California Energy Commission.

Residential Standards

The Standards for residential buildings establish an energy budget for space heating, space cooling water heating, and lighting. The energy budget is based on energy use (measured in BTUs or British Thermal Units) used per square foot per year. Standards are set for certain areas of home energy use and efficiency, which are listed below. The specific amount of each item depends upon the climate zone:

» Insulation (ceiling, wall, floor, and ducts);

» Heating, ventilation and air conditioning;

» Water heater;

» Water consumption;

» Lighting;

» Windows; and

» Cool roofs.

Under the prescriptive approach, there are alternative component packages for each of the state's 16 climate zones. Each package is a list of measures, including additional insulation, window glazing, shading, infiltration control, space heating and cooling, and water heating.

Nonresidential Standards

Nonresidential Standards cover the building envelope, heating, ventilation and air conditioning (HVAC) equipment, and lighting systems. Mandatory measures for the nonresidential Standards include minimum efficiencies for HVAC equipment, installation of low-flow faucets, lighting controls, and the use of certified fluorescent ballasts and automatic lighting controls. Building permit applicants show compliance by meeting the mandatory measures and using either the prescriptive or performance approach.

When using the prescriptive approach, the building's insulation and glazing (windows and skylights) must meet a minimum efficiency level either individually or when analyzed together. Lighting designs are required to demonstrate energy use levels (in watts per square foot) established for either the general occupancy type or the specific visual tasks of the building's tenants. The HVAC system compliance is documented by meeting both minimum ventilation, air quality criteria, and by providing cooling and heating load calculations used to size the capacity of the HVAC equipment.

As with the residential Standards, the performance approach is met by using an approved software program. The program is used to determine the energy budget for the applicant's building type incorporating standard energy features, and to demonstrate that the building design, with its actual energy features, uses no more energy than the calculated standard energy budget.

Why California Needs Standards

Energy efficiency reduces energy costs for owners, increases reliability and availability of electricity for the State, improves building occupant comfort, and reduces environmental impact.

Energy Savings. Reducing energy use is a benefit to all – building owners save money, Californians have a more secure and healthy economy, the environment is less negatively impacted, and our electrical grid can operate in a more stable state. Revisions to the Standards implemented in 2001 and 2005 in response to the California energy crisis resulted in 330 megawatts (MW) of demand reduction (conservation). The 2008 Standards (for residential and nonresidential buildings) are expected to reduce the growth in electricity use by 561 gigawatt-hours per year (GWh/y) and reduce the growth in gas use by 19.0 million therms per year (therms/y). The savings attributable to new nonresidential buildings are 459 GWh/y of electricity savings and 11.5 million therms. Savings from the application of the Standards on building alterations accounts for 270 GWh/y and 8.2 million therms. These savings are cumulative, doubling in two years, tripling in three, etc.

Comfort. Comfort is an important benefit of energy efficient buildings. Energy efficient buildings include properly designed HVAC systems, which provide improved air circulation, and high performance windows and/or shading to reduce solar gains and heat loss. Poorly designed building envelopes result in buildings that are less comfortable.

Economics. Building energy efficiency improvements save money for the building owner and reduce California's dependence on non-renewable resources. In many ways, it is more cost-effective for the people of California to invest in saving energy than it is to invest in building new power plants.

Environment. The use of energy has led to oil spills, acid rain, smog, and other forms of environmental pollution that have ruined the natural beauty people seek to enjoy. Reductions in building energy consumption lessen the impact of energy use on the environment.

Greenhouse Gas Emissions and Global Warming. Energy efficiency is a far-reaching strategy that is making an important contribution to the reduction of greenhouse gases. The Standards, for example, are expected to have a significant impact on reducing greenhouse gas and other air emissions: carbon dioxide would be reduced by 473,000 tons first year of construction, cumulative each year thereafter.[1]

Endnotes

1. CEC. 2008. *Nonresidential Compliance Manual.* Sacramento: California Energy Commission. www.energy.ca.gov/title24/2008standards/rulemaking/documents.

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IMPROVE ENFORCEMENT OF BUILDING ENERGY STANDARDS

The first Residential and Nonresidential Building Energy Efficiency Standards went into effect in the mid-1970s. California's Building Energy Efficiency Standards have saved the state billions of dollars (see below for detail). These savings will continue to grow as the standards are updated and as more buildings are built to meet the standards. But to achieve these savings, the standards must be enforced by local building officials. This section provides ideas on how to improve compliance with the Building Energy Efficiency Standards through enforcement.

The Governor has assured the U.S. Department of Energy that California will increase its compliance with the Building Energy Efficiency Standards to 90 percent by 2018. Every city and county will need to be effective in its own jurisdiction in order for the State to achieve its assurance.

General Plan Language Ideas

» The Building Department shall rigorously enforce California's Residential and Nonresidential Building Energy Efficiency Standards. The Building Department shall provide guidance and assistance to applicants to make the process as effective and efficient as possible.

Implementation Ideas

» **Establish a clear commitment.** City Council, County Board of Supervisors, management, and staff must be committed to enforcing the Building Energy Efficiency Standards.

» **Educate and Train personnel.** Ask the California Energy Commission to evaluate the city/county's effectiveness in enforcing Title 24 standards. The Energy Commission's Building Standards Office has contracted with California Building Officials (CALBO)[1] to conduct on-site training following such evaluations. Education and training options are also available through various utilities, consultants, and private organizations, and available on-line at http://www.energyvideos.com.

» **Provide permit applicants with useful and necessary information.** Distribute information sheets at the permit counter. Provide individualized assistance to applicants who need it. Arrange for local training of building designers and project applicants.

» **Provide annual reports on implementation and enforcement.** The Building Department will provide an annual report to the council/board regarding the status of implementing and enforcing the Building Energy Efficiency Standards. The report will include a set of performance measures for tracking compliance with the standards throughout the local jurisdiction.

Energy Savings

Changes to the state's Building Energy Efficiency Standards in 2001 (following the electricity crisis) have reduced electricity demand by about 150 megawatts (MW) each year. The 2005 standards are expected to reduce electric demand by another 180 MW each year.[2]

Environmental Benefits

Electricity generation, both in- and out-of-state, and other residential and commercial energy use accounts for 32 percent of California's greenhouse gas (GHG) emissions, second only to the transportation sector.[3] Improving energy efficiency through increased enforcement of the standards could reduce these emissions, as well as emissions of other pollutants for which federal and state standards exist – carbon monoxide, nitrogen oxides, organic gases, sulfur oxides, and particulate matter. The standards are updated periodically and are on target to reach zero net energy residential buildings in 2020 and nonresidential buildings in 2030 which aligns with the mandates of AB 32, the Global Warming Solutions Act of 2006, to reduce GHG emission to 1990 levels by 2020.

Economic Considerations

California's Building Energy Efficiency Standards (along with the Appliance Efficiency Standards) have saved more than $56 billion in electricity and natural gas costs since 1978. It is estimated the standards will save an additional $23 billion by 2013.[4]

The primary cost to local governments for enforcing the Building Energy Efficiency Standards is staff time. Costs for an individual city or county will depend upon existing enforcement efforts, permit fees, and staff salaries. Jurisdictions should provide time expenditure for their plan reviewers and inspectors in order for them to become educated on the standards and to be equipped to enforce them.

Resources

The California Energy Commission's Building Standards Compliance and Enforcement Unit provides assistance to building department personnel and other energy professionals to increase compliance with the standards and receives, investigates, and resolves any related complaints. Hotline is available to assist building department personnel, consultants, and project applicants with questions about the standards. An on-line Learning Center, developed for the 2008 standards, contains tutorials, curriculum, videos, and a tool kit of resource materials and can be accessed at http://www.energyvideos.com. Contact: 1-800-772-3300 or 1-916-654-5106, e-mail at: title24@energy.state.ca.us.

Founded in 1962, CALBO is an association of building officials of California municipalities that provides professional advancement and continuing education opportunities. Courses give special emphasis to providing the knowledge and skills necessary to enforce all building regulations, including energy efficiency standards. CALBO also offers credentials for building officials, field inspectors, plans examiners, counter technicians, design professionals, and code enforcement. http://www.calbo.org.

Phase I regulations establishing field verifications and diagnostic testing services administered by Home Energy Rating System (HERS) providers became effective on June 17, 1999. The California Certified Energy Rating and Testing Services (CalCERTS), California Building Performance Contractors Association (CBPCA), and the California Home Energy Efficiency Rating System (CHEERS) have been approved by the Energy Commission as HERS providers to oversee HERS raters providing Title 24 field verification and diagnostic testing. People interested in becoming certified HERS raters should contact CalCERTS, CBPCA, or CHEERS. http://www.CalCERTS.com, http://www.CBPCA.org, http://www.CHEERS.org.

Related Strategies

B.1.2	Going Beyond State Building Energy Standards
B.1.3	Solar Energy

Endnotes

1. For more information visit: www.energy.ca.gov/title24/training/index.html.
2. CEC. 2005. *Title 24 Energy Efficiency Standards.* Sacramento: California Energy Commission. http://extension.ucdavis.edu/unit/green_building_and_sustainability/pdf/resources/title_24.pdf.
3. ARB. 2008. C*limate Change Proposed Scoping Plan: A Framework for Change.* Sacramento: California Air Resources Board. http://www.arb.ca.gov/cc/scopingplan/document/psp.pdf.
4. CEC. 2005.

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GOING BEYOND STATE BUILDING ENERGY STANDARDS

Since first adopted in the mid-1970s, California's energy efficiency standards for new buildings (often referred to as Title 24) have resulted in substantial energy and economic savings. (See Background: State Energy Efficiency Standards for New Buildings in the Introduction to the Building Policies section.) While the energy efficiency standards for new buildings reflect minimum cost-effective technologies and practices, they do not necessarily require all achievable levels of cost-effective energy efficiency.

The 2008 California Green Building Standards Code (California Code of Regulations Title 24, Part 11) is incorporated into the 2008 revision of the Building Energy Efficiency Standards. The code standardizes practices for reducing the environmental impact of buildings in a variety of ways, from cutting water and electricity consumption to using less resource-intensive building materials. Application of the code is currently voluntary.

Local governments can adopt additional, cost-effective building practices that go beyond state standards in order to reduce energy consumption. This section provides ideas for how local governments can do so.

Communities Going Above and Beyond

At the time of publication, fourteen local governments in California had adopted ordinances exceeding the 2005 building energy efficiency standards. Local governments are required to apply to the Energy Commission for approval, documenting the supporting analysis for how the local government has determined that its proposed standards will save more energy than the current statewide standards and the basis of the local government's determination that the local standards are cost-effective. For a list of communities that have adopted ordinances that are more stringent than state code, visit http://www.energy.ca.gov/title24/2008standards/ordinances.

General Plan Language Ideas

» The City/County shall adopt new building efficiency practices for commercial, industrial, and residential buildings to reduce energy consumption below the amounts that would be used if the buildings only complied with the existing state standards.

» If the City/County finds that energy and water conservation measures (in addition to those required by state standards) are cost-effective for a proposed development, the City/County shall recommend such measures. The City/County shall determine cost-effective measures based upon a payback period of 30 years or less.

» The City/County shall work with the utility to offer a technical assistance program to developers of new projects. The program will offer technical advice on energy and water conservation measures that will result in savings above current state standards in commercial, industrial, institutional, and large scale residential developments.

» Within one year, the City/County shall implement a program to offer incentives for new developments that are more energy efficient than state energy standards at the time the building permit is issued. Incentives may include reduced permit fees or expedited permit processing. A similar program shall be adopted for water conservation. The City/County will recognize outstanding projects through an annual awards program.

» In all new construction, each residential unit, commercial/industrial space, agricultural area, large landscaped area (commercial development), and other water/energy using entity shall be metered separately for water/energy consumption. [Alternately, a submeter or data feedback provision shall be made to inform a user of cumulative and/or instantaneous power demand.]

» The City/County shall adopt the United States Green Building Council's "LEED" rating system (Leadership in Energy and Environmental Design) for nonresidential buildings and the Build It Green GreenPoint Rated system for residential buildings.

» The City/County shall adopt new building efficiency practices in which the level of energy consumption of homes larger than 3,500 square feet use no more total TDV[1] energy under the standards than an equivalent 3,500 square foot house.[2]

Implementation Ideas

» **Adopt a "Best Practice" program.** Establish an advisory committee, including technical experts, to determine how local building practices could be revised to exceed existing state minimum energy efficiency standards and state standards for water fixtures.

To ease implementation, the "best practice" program should be structured as an extension of the state standards, rather than using a new format or compliance method. Under the building energy efficiency standards, developers can comply using either a performance standard based on meeting an energy budget, or a prescriptive standard which includes implementation of one of several packages of specific measures designed to meet the energy budget. Local "best practice" programs could include: 1) a tighter energy budget, such as a specified percent reduction in total energy use over the current performance standard (10-20 percent tighter); and/or 2) more efficient prescriptive measures. Increased prescriptive measures might include more insulation, more efficient windows, solar water heating, more daylighting, or more energy and water efficient appliances. Required measures should have reasonable payback periods (four to seven years or less). In addition, a water use budget could be established. After adopting a "best practice" program, offer an education program to explain the requirements to building professionals.

» **Establish a technical assistance program.** Establish a program to aid developers in selecting energy and water conservation measures that result in savings that exceed the state standards. If no fees are charged, the service could be limited to certain land uses and/or only large developments. The service could be a partnership with local utilities, with the utilities providing startup costs and/or ongoing funding, which could be tied to the amount of energy and water saved. Alternatively, the utility could operate the program. For large commercial or industrial developments, the program should include building operator training in order to ensure long-term energy efficiency.

- **Require energy and water use evaluations.** Require proposed, large-scale commercial and industrial development to undergo a comprehensive energy and water use evaluation. The analysis would provide the developer with information on energy and water conservation measures that could be implemented resulting in savings beyond state standards. The evaluation could be provided through a technical assistance program (described above), the utility, or by private consultants certified by the local government. Developers of large-scale discretionary projects could be advised to include the cost-effective measures recommended in the evaluation (e.g., any measure with a payback period of seven years or less).

- **Offer incentives for extra-efficient projects.** Faster permit processing is often difficult to implement but is the most valuable incentive to many developers. More efficient buildings could pay lower permit fees. Density or height bonuses, another incentive, may conflict with other land use policies.

- **Monitor installation and results.** Establish a tracking and monitoring program to assure that promised efficiency measures are actually installed and operated correctly. Installation can be checked by building inspectors. Another system, perhaps in conjunction with the utility, may be needed to assure proper operation in subsequent years.

- **Require new residential construction to exceed Title 24 by being built according to state-of-the art standards.** "Build It Green" and Leadership in Energy and Environmental Design (LEED) provide state-of-the art standards and guidelines for energy efficient building design. See the Resources section below for more detail.

Energy Savings

Overall energy savings will depend upon the program adopted. Stricter building practices must take into account climate, available technology, and economics. These may vary by area and change over time. Savings from technical assistance programs are highly dependent upon how many developments use the service and implement the recommended measures. Requiring energy and water use evaluations prior to building approval may increase the number of buildings receiving technical advice. Offering incentives should increase the effectiveness of both technical assistance and mandatory evaluation programs.

Examples of payback periods for some specific residential technologies in new construction (calculated for Santa Monica) are presented in the table on this page. In general, more efficient heating, water heaters, and appliances provide payback periods of less than five years.[3]

Energy Efficiency Measure	Simple Payback (Years)
Efficient domestic gas-fired water heater	4.7
Whole house gray water heat recovery system	4.9
Fenestration U-value of 0.40	8.6
Energy Star refrigerator	3.0
Energy Star dishwasher	2.5
Horizontal-axis Energy Star clothes washer	4.8
Natural gas dryer	4.6

Environmental Benefits

Reducing building energy demand will reduce air pollutant emissions from electric power plants and natural gas equipment in homes. For example, The City of Santa Monica estimated that Green Building Ordinance measures could curb its future energy usage by more than 1,000,000 kWh of electricity and 30,000 therms of natural gas annually, reducing CO_2 emissions by 460 metric tons, and saving ratepayers over $190,000 in annual utility bills.[4]

Cobenefits of energy efficiency investments include increased comfort (fewer temperature extremes), reduced noise exposure (due to higher insulation in walls and ceilings, and better windows), and improved indoor air quality.

Economics

Over time, building owners and occupants could save money if they implement appropriate energy conservation measures. Cost effectiveness of residential technologies when measures are installed as retrofits may be significantly lower. Requiring or encouraging capital expenditures for efficiency improvements can also foster local energy conservation businesses.

For Rohnert Park's Green Building program, the Ordinance increases the cost of construction by approximately $0.20 to $0.70 per square foot, for which the energy cost savings as a simple payback from first cost is typically in the range of 5 to 15 years. If the overall cost of new residential construction, including the cost of land and other related permit fees, is in the range of $300 to $350 per square foot, the Ordinance will increase that overall cost by approximately one-tenth to two-tenths of one percent.

The costs of providing a technical assistance program will depend upon the scope of the services provided, the number of projects using the service, financial or in-kind support from local utilities, and any fees imposed for the services.

Local governments will incur the costs of developing stricter building standards. Once the practices are established, implementation costs should not be higher than current costs for development review. Updates of the practices could impose additional costs. Costs could be covered by building permit fees or cooperative utility agreements. Programs can be made more effective and lower cost by coordinating with other cities and technical support programs such as Build it Green and LEED.

If the developer or utility pays for the evaluation, requiring buildings to undergo an energy use evaluation should not pose major costs to local governments. Some staff time may be needed to review the evaluation if the City/County intends to recommend that the development implement the measures.

Programs in Operation

In **Culver City**, new commercial or multifamily construction is required to install one kilowatt of solar photovoltaic power per each new 10,000 square feet of construction. The permit applicant may instead pay an equivalent amount into a city fund to pay for solar systems on city or local nonprofit facilities. In addition, all new buildings must comply with current Title 24 standards at the time of construction. Ordinance language is available at: http://www.energy.ca.gov/title24/2005standards/ordinances/2007-06-20_CULVER_CITY.pdf.

The City of **La Quinta** voted to adopt and enforce the 2005 Title 24 energy standards before the standards went into affect statewide, using California Energy Commission findings of cost effectiveness. To view the letter of application, go to: http://www.energy.ca.gov/title24/2005standards/ordinances/2006-12-20_LA_QUINTA.pdf.

The City of **Palo Alto** enforces mandatory green building standards for residential and commercial building projects. The green building ordinance specifies use of the U.S. Green Building Council's LEED rating system for nonresidential buildings and the Build It Green GreenPoint Rated system for residential buildings. Both systems specify minimum energy efficiency standards that exceed the 2005 Title 24 requirements. The city planned to reapply before the 2008 standards take effect. Palo Alto's application to the Energy Commission is available at: http://www.energy.ca.gov/title24/2005standards/ordinances/2008-11-05_PALO_ALTO.pdf.

Marin County received permission from the Energy Commission to require more stringent energy performance than the State's Title 24 standards. The ordinance requires all homes of 1,500 square feet or larger (including all additions and substantial remodels) to exceed Title 24 by 15 percent. It also requires homes larger than 3,500 square feet to consume no more energy than allowed for a 3,500 square foot home through higher efficiency equipment, installation of solar energy systems, or reduction of total conditioned floor area. Since it was adopted in 2002, over 2.5 million kWh have been saved and approximately 870 tons of GHG has been reduced annually. Information available at: http://www.co.marin.ca.us/depts/CD/Forms/Energy_Efficiency_Ordinance_-_Applicant_Info.pdf.

The City of **Santa Monica** requires new residential construction to be 10 percent more efficient than Title 24. The ordinance uses a prescriptive method that includes packages of measures. The city determined that installation of a whole house graywater heat recovery system alone beat Title 24 by 25 percent and had less than a five year payback. Eighty to ninety percent of hot water energy usage goes down the drain. Graywater heat recovery systems use heat exchanger technology to transfer over 60 percent of the heat from drainwater to incoming cold water. This results in increased domestic water heating capacity for the domestic water heating system, and significantly reduces domestic water heating consumption. Graywater heat recovery systems are effective for single family, multifamily low-rise, and high-rise residential applications, as well as laundry facilities. Other packages include efficient water heater and energy star appliances that can add another six to eight percent savings with around three year payback periods. The Santa Monica ordinance is available at: http://www.energy.ca.gov/title24/2005standards/ordinances/2006-12-20_SANTA_MONICA.pdf.

San Francisco has adopted an ordinance to require all new buildings to exceed Title 24 requirements. Small and mid-sized residential projects (less than 75 feet tall) must be 15 percent better than Title 24 and have receive a certain number of Green Point Rating points (see resources below). High-rise residential (75 feet or taller) and commercial projects must meet LEED building standards. The ordinance is available at: http://www.energy.ca.gov/title24/2005standards/ordinances/2008-09-26_SAN_FRANCISCO.pdf.

Resources

The Energy Efficiency Standards for Residential and Nonresidential Buildings may be downloaded from the California Energy Commision's web site at: http://www.energy.ca.gov/title24.

The California Residential Compliance Manual and Nonresidential Compliance Manual discuss design and compliance issues of the energy efficiency standards and include a number of suggestions for going beyond minimum requirements.

» The nonresidential manual is available for download at http://www.energy.ca.gov/title24/2005standards/nonresidential_manual.html.

» The residential manual is available for download at http://www.energy.ca.gov/title24/2005standards/residential_manual.html.

The California Energy Commission maintains an Energy Hotline that provides assistance to energy professionals to increase compliance with Title 24. Call (800) 772-3300 or e mail title24@energy.state.ca.us.

California's electric and gas utilities offer information, trainings, and equipment demonstrations at their energy resource centers to help customers make informed energy decisions. Visit their web sites for more information.

» PG&E's Pacific Energy Center and Stockton Training Center: http://www.pge.com/pec.

» Sacramento Municipal Utility District; http://www.smud.org/en/education-safety/Pages/index.aspx.

» Southern California Edison's Customer Technology Application Center (CTAC) and Agricultural Technology Application Center (AGTAC): http://www.sce.com/b-sb/energy-centers.

» Southern California Gas Company's Energy Resource Center: http://www.socalgas.com/business/resourceCenter/ercOverview.html.

Build It Green is a nonprofit membership organization whose mission is to promote healthy, energy- and resource-efficient building practices in California. Build It Green offers green building training, tools, technical expertise, and partnership opportunities for key stakeholders including public agencies, builders, developers, architects, contractors, affordable housing advocates, real estate professionals, suppliers, and homeowners. GreenPoint Rated is a program of Build It Green, which removes the guesswork by having a Certified GreenPoint Rater evaluate a home's green features allowing homes to be compared on a level playing field. However, special care must be taken if a city/county is using the GreenPoint Rated program without a certified Rater or the requirement to be certified under GreenPoint Rated. Under those conditions, a city/county must specifically ensure that the building will, at a minimum, comply with the California Building Energy Efficiency Standards (Title 24, part 6) under a parallel review process. Contact: http://www.builditgreen.org.

Leadership in Energy and Environmental Design (LEED) is a third-party certification program and the nationally accepted benchmark for the design, construction and operation of high performance green buildings. LEED for Homes is a rating system that promotes the design and construction of high-performance green homes. A green home uses less energy, water and natural resources; creates less waste; and is healthier and more comfortable for the occupants. Benefits of a LEED home include lower energy and water bills; reduced greenhouse gas emissions; and less exposure to mold, mildew, and other indoor toxins. The net cost of owning a LEED home is comparable to that of owning a conventional home. However, special care must be taken if a city/county is using the LEED program without the requirement to become certified under LEED. Under those conditions a city/county must specifically ensure that the building will, at a minimum, comply with the California Building Energy Efficiency Standards (Title 24, part 6) under a parallel review process. More information: http://www.usgbc.org/homes.

Related Strategies

B.1.1 Improve Enforcement of Building Energy Standards

B.1.6 Efficient Lighting

Endnotes

1. Time Dependent Valuation of Energy or (TDV Energy) is the time varying energy caused to be used by the building to provide space conditioning and water heating and, for specified buildings, lighting. TDV Energy accounts for the energy used at the building site and consumed in producing and in delivering energy to a site, including but not limited to, power generation, transmission and distribution losses. TDV Energy is expressed in terms of thousands of British thermal units per square foot per year (kBtu/sq.ft.- yr.).
2. CTG Energetics, Inc. 2005. *Evaluation of Santa Monica Energy Efficiency Standards Relative to 2005 Title-24 Standards.* Santa Monica: City of Santa Monica Energy & Green Buildings Department. www.energy.ca.gov/title24/2005standards/ordinances/2006-12-20_SANTA_MONICA.pdf.
3. Ibid, using ICLEI's carbon dioxide conversion rates for Souther California Edison and an average for natural gas in 2005.

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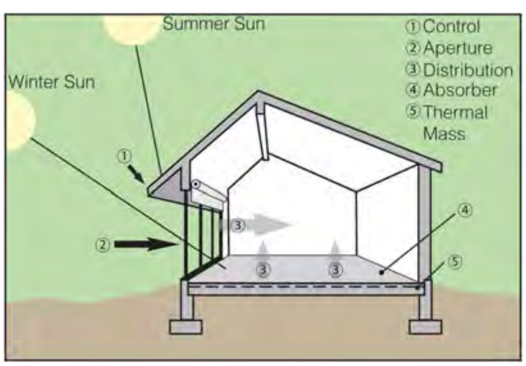
SOLAR ENERGY

Planning for solar access and orientation is an important first step in building energy efficient communities. East-west street orientation allows houses to be plotted with the majority of windows facing north or south. With proper use of overhangs, this allows summer heat gain through windows to be dramatically reduced, and facilitates passive solar heating and lighting in winter. It also allows active energy systems such as solar panels for electricity generation and water heating to be located on the south roof exposure where they are most effective. Attractive "building-integrated" solar panels can help eliminate objections to their appearance on aesthetic grounds.

This section provides ideas for how local governments can support use of solar resources through the planning and building permitting processes; by incentivizing the use of passive and active solar features; and by enforcing solar-energy related laws (see below for more detail).



Passive Solar Design.
Graphic: California Energy Commission.

Passive versus Active Solar Features

Passive solar features take advantage of the heating power of the sun through building siting, design, and orientation – not mechanical devices. These features reduce building energy needs.

Active solar features are mechanical systems (e.g. solar panels) that generate power from the sun's rays, thereby reducing the amount of energy that needs to be purchased from a utility company.

Existing Solar-Related Laws

Several older California laws provide the right to solar access, help prevent restrictions that may prevent the installation of solar products, and provide consumer protections. Civil Code 714 disallows provisions in covenants and restrictions that prohibit solar energy systems, and requires that systems be approved by the appropriate testing and code agencies.

Civil Code 801.5 defines solar easements and describes what instruments creating them shall include. Government Code 65850.5 restricts local agencies from adopting ordinances that create unreasonable barriers to the installation of solar energy systems, including design review for aesthetic purposes.

The Solar Rights Act and Solar Shade Control Act of 1978 (Government Code 66473.1) require that subdivisions, to the extent feasible, provide for future passive or natural cooling opportunities, and allows cities and counties to adopt solar easements and to prohibit the planting of trees or shrubbery that would shade more than 10 percent of the solar absorption area between 10 a.m. and 2 p.m. The Solar Rights Act enforces the right of local governments to require solar easements, including design of lot size and configuration to permit orientation of a structure in an east-west alignment for southern exposure, however it excludes requirements that would reduce allowable densities.

SB 1399 of 2008 amended the Public Resources Code to exempt trees and shrubs planted prior to the installation of a solar system, as well as plantings that are subject to a local ordinance, or the replacement of trees or shrubs that had been growing prior to the installation of the solar device. The Solar Shade Control Act was introduced before photovoltaic (PV) systems became prevalent and was aimed at solar thermal systems. Partial shading of PV modules has much more dramatic effect on electricity output than shading of solar thermal collectors, and this should be considered in the development of local ordinances.

Existing Solar Programs and Incentives

In January 2007, the State of California launched an unprecedented $3.3 billion ratepayer-funded effort that aims to install 3,000 megawatts (MW) of new solar over the next decade and to transform the market for solar energy by reducing the cost of solar. SB 1 is the legislation that codified these goals and Governor Schwarzenegger's "Million Solar Roofs Initiative." SB 1 directs investor-owned and publicly owned utilities with goals to: 1) install solar energy systems by 2017 with a generation capacity of 3,000 megawatts; 2) establish a self-sufficient solar industry so that by 2017 solar energy systems are a viable mainstream option for homes and commercial buildings; and 3) put solar energy systems on 50 percent of new homes.

Of this $3.3 billion, the California Public Utilities Commission's California Solar Initiative (CSI) Program has a budget of $2.1 billion for the three largest investor-owned utilities (PG&E, SCE, and SDG&E), and a goal to reach 1,940 MW of installed solar capacity by the end of 2016. The Energy Commission's New Solar Home Partnership (NSHP) has a budget of $400 million for the three largest investor-owned utilities (PG&E, SCE, and SDG&E), and a goal of 360 MW of installed solar capacity by the end of 2016. Finally, the publicly owned utilities have a combined budget of $784 million and goal of 700 MW, divided and prorated amongst all publicly owned utilities based on their share of annual peak load.

The NSHP incentive program for new homes requires that certain levels of energy efficiency be met as a prerequisite (at least 15 percent better than the current Title 24 standards), insuring that permanent, more cost-effective improvements are made before solar rebates can be claimed. On the assumption that solar electric systems will be declining in cost, rebates are ramping down as a function of the amount of capacity that has been installed.

Another state incentive is offered in the form of a property tax exemption. Section 73 of the California Revenue and Taxation Code exempts qualified solar energy systems from property tax assessments. This includes systems that generate electricity and that produce hot water for domestic use.

The Federal Energy Policy Act of 2005 (Section 1335) established a 30 percent tax credit up to property and a 30 percent tax credit up to $500 per 0.5 kilowatt for fuels cells. Initially scheduled to expire at the end of 2007, the tax credits were extended through December 31, 2008 by Section 206 of the Tax Relief and Health Care Act of 2006. In October 2008, through the Energy Improvement and Extension Act of 2008 (Division B, Section 106), the tax credits were extended once again – until December 31, 2016 – and a new tax credit for small wind energy systems and geothermal heat pump systems was created. This new legislation also eliminated the $2,000 cap on the tax credit for the purchase and installation of solar electric on residential properties, thus making solar energy investment paybacks more attractive. Utilities may now also benefit from the credit as eligible tax credit recipients.

General Plan Language Ideas

» In accordance with the Solar Rights Act of 1978, the City/County shall deny a tentative map of a subdivision that does not meet the design requirements of the Act.

» By [date], the City/County shall revise the subdivision ordinance and review process to ensure effective implementation of the State Solar Rights Act, including a requirement for solar access easements.

» The City/County shall cooperate with property owners to enforce the Solar Shade Control Act of 1978 protecting solar access.

Implementation Ideas

» **Enforce state laws** relating to the utilization of solar energy:

- Adopt a solar access ordinance and/or include more specific or stronger requirements in the subdivision ordinance.
- Require solar access easements in new subdivisions as a condition of approval.
- Enforce the Solar Shade Control Act by instituting a penalty process.
- Develop a city/county policy for lot setbacks, and an approved list of street trees to minimize future shading of solar panels.
- Require review of homeowner's association requirements (CC&Rs or "covenants, conditions, and restrictions") to ensure they do not prohibit the use of rooftop solar equipment and outdoor clotheslines (otherwise known as solar clothes dryers).

» **Require homes to be "solar ready:"**

- Oriented for maximum solar exposure;
- Prewired and pre-plumbed for solar PV systems and solar water heaters; and
- Have strong enough roofs to handle the weight of the solar systems.

» **Adopt a retrofit program** similar to that developed by the cities of Berkeley and Palm Desert to provide financing (under AB 811 legislation) for home energy improvements, including solar water heating and photovoltaic systems. See C.1.2 Community Energy District Financing for more details.

» **Adopt ordinances, standard development agreements, and/or form based codes** that require that new homes to be built to Energy Star standards (at a minimum), and require PV systems on a designated percentage of new homes.

» **Review building permit fees for solar energy systems** and provide a favorable fee structure and turnaround time for approval. There are currently several efforts to streamline permitting processes, see the resources section for more information.

» **Provide developers and builders information about renewable energy incentive and energy efficiency programs** offered by the California Energy Commission, U.S. Department of Energy, and utilities when they apply for permits and encourage them to participate. The California Energy Commission (http://www.energy.ca.gov) and Go Solar California (http://www.gosolarcalifornia.ca.gov) web sites provide supporting materials and links to builders, installers, local agencies, and prospective buyers of solar energy systems.

Energy Savings

Orienting well-insulated buildings to maximize southern window exposure and minimizing windows on the east and west walls can reduce heating and cooling needs by 10-20 percent in many climates.[1]

Homes that are built using many features of passive solar design (including improved insulation, reflective roofs and radiant barriers, solar orientation, enhanced thermal mass, and properly sized overhangs and other window shading), can contribute to reduce gas and electric energy use by up to 30 percent. A solar water heater can reduce natural gas consumption by 40-70 percent and typically sized photovoltaic systems save over 50 percent of electrical energy use.[2]

Homes built to "near zero energy" standards can be affordable and save as much as 60 percent relative to houses built to Title 24 standards. Some builders have learned they can recover their costs, not from higher sales prices, but from reduced carrying costs resulting from a faster rate of sales compared to competing builders.[3]

Environmental Benefits

Reducing heating and cooling demand reduces air pollutant emissions from electric power plants and natural gas heaters.

The U.S. National Renewable Energy Laboratory calculates the current technical potential of solar water heating in

Solar oriented library with PV system.
Photo: California Energy Commission.

the United States at one Quad (a unit of energy equal to 1015 BTU) of primary energy savings per year, equivalent to an annual CO_2 emission reduction of about 50 to 75 million metric tons.[4]

Economics

Energy improvements, including improving efficiency and adding solar water heating and photovoltaics, can be made such that the energy savings completely offset their cost. This cost neutrality has been demonstrated for new homes through the U.S. Department of Energy-

Net Zero Energy Buildings

When renewable energy systems such as solar water heating and photovoltaics are combined with more efficient equipment and systems, "net zero energy" buildings can be constructed that generate as much energy as they use on a net annual basis.

sponsored Building America program and the California Energy Commission's Zero Energy New Homes program. The enormous benefit of improving efficiency and using renewable energy sources is that the added "Megawatts" of energy capacity from these resources is completely paid for out of energy savings, eliminating the need for investments in new utility power plants and reducing demand for non-renewable energy resources, both of which help keep energy prices affordable.

Until costs for renewable systems decline, however, they will continue to be less cost-effective than energy efficiency improvements such as improving insulation and installing better windows and more efficient heating and cooling systems. Combining higher priced renewable systems with less costly efficiency items can reduce the payback period for a retrofit project. The economics of

Bundling the Costs of Solar PV systems with Energy Efficiency Measures

Solar PV and other renewable energy systems can be costly. One way of reducing the cost is to combine purchase of solar PV systems with energy-efficiency measures such as improving building insulation and testing for and sealing leaks. These energy-efficiency measures can reduce the overall energy needs of the building and potentially allow purchase of a smaller, less costly PV system.

solar thermal and electric systems are still dependent on incentives, but with anticipated breakthroughs in technology this trend could reverse. In the 1980s, the retail price for photovoltaics was over $20/Wp (peak watt); the industry average in 2009 is just over $4/Wp. The industry has set a 2010 goal of reducing that price to less than $1.50/Wp. If realized, this could provide broadly competitive system offerings in the residential market, without subsidies. The PV panels typically make up about one half of the total system cost.[5]

In some cases, site planning for solar access can increase the number of units in a subdivision and reduce construction costs. For example, in an analysis of solar design, the California Energy Commission redesigned a proposed subdivision in Sacramento so that street orientation and lot shape optimized solar access protection. The solar-oriented plan included more lots (103 versus 96), decreased the amount of street area required by over 12,000 sq. ft., and increased the number of solar-oriented lots by 40 percent (from 58 to 81).[6] The Local Government Commission's Local Energy Assistance Program, funded by the investor owned utilities under the auspices of the California Public Utilities Commission, reoriented over 40 subdivision plans to maximize passive solar heating and cooling, and did not decrease the number of lots in any of the projects.[7]

Programs in Operation

Solar **Santa Monica** is a city-sponsored program that helps residents save energy through energy efficiency, and then helps them produce energy using solar systems. The goal is to have the city to be making most of the power it needs by 2020. The plan is to improve the efficiency of every building in Santa Monica, and put solar panels on 17,400 roofs. In its first year (2007), Santa Monica doubled its solar capacity over what it had installed up to that date. The program includes:

» A free, comprehensive On-Site Solar Assessment for businesses and a do it yourself energy survey for homeowners;

» Referrals to specialized solar lenders;

» Referrals to other specialists such as plumbers, roofers, landscapers, etc.; and

» Assistance with comparing competing bids for solar or efficiency home-upgrade projects.

http://www.solarsantamonica.com.

Marin County's Energy Conservation Code is designed to ensure that new subdivisions provide for future passive or natural heating or cooling opportunities in the subdivision to the extent feasible. Streets, lots, and building setbacks must be designed so that habitable buildings are oriented with their long axis running east to west (with a possible variation of 30 degrees to the southwest and 30 degrees to the southeast) for the purpose of solar access. The planning director or planning commission may require solar access easements or restrictive covenants to protect solar access. http://www.co.marin.ca.us/depts/CD/main/comdev/ADVANCE/index.cfm.

The Village Homes subdivision in **Davis** is an example of a vintage solar-oriented development. Most of the homes were designed using simple passive solar techniques – orienting homes to the south, placing most windows on the southern side, using overhangs or arbors on southern windows to provide shade in the summer, and using operable windows on the north and south walls for cross-ventilation. With overhead fans, the solar orientation makes living without air conditioning possible in the hot Davis summers. Solar access was part of the original subdivision design and provisions in the codes, covenants, and restrictions assure continued access by prohibiting shading. http://www.lgc.org.

The San Jose Environmental Services Department has developed voluntary guidelines to encourage solar orientation in new construction. These Solar Access Design Guidelines specify that the long axis of new dwellings should face within 30 degrees west and 45 degrees east of true south. Because houses in a subdivision usually face the street, planners in San Jose found that the easiest way to achieve solar orientation was to orient the streets within 30 degrees of the true east-west axis. Homes in such a subdivision would have good solar orientation by default. The solar orientation guidelines have been incorporated into the City's residential design guidelines. http://www.sanjoseca.gov/planning/design_guidelines.

The City of **Santa Cruz** is developing a planning checklist that corresponds to its green building program. The guide is intended to pinpoint specific design phase opportunities for use of natural elements such as solar radiation and wind direction to positively affect building performance and occupant comfort. Developers are urged to include efficient or solar powered heating systems for hot tubs and swimming pools where feasible. Santa Cruz also eliminated the need to obtain a design permit for installation of solar energy systems. http://www.ci.santa-cruz.ca.us/pl/building/green.html.

The City of **Berkeley**'s SmartSolar program is operated by Community Energy Services Corporation in partnership with the cty and the U.S. Department of Energy's Solar American Cities Initiative. It is a free service for Berkeley residents and businesses and provides:

» A free energy audit of homes and businesses;

» Free, independent advice on a property's solar potential and the best solar solution;

» A vendor list with information collected from area contractors;

» Assistance in evaluating project bids; and

» Resources and advice throughout the installation process.

http://www.ebenergy.org/smartsolar.

The Berkeley FIRST program also offers on-tax bill financing for energy efficiency and renewable energy projects. See Strategy C.1.2 Community Energy District Financing for more details.

Resources

The State of California's Go Solar California program includes the New Solar Homes Partnership and California Solar Initiative programs. http://www.gosolarcalifornia.org/csi/index.html.

Information on California solar access laws can be found on the California Solar Industries Association web site at http://calseia.org/solar-rights.html.

There have been many changes to solar laws and incentive programs over the past decade, and with increasing awareness of global climate change and sustainability, more can be expected. The Database of State Incentives for Renewable Energy (DSIRE) provides a comprehensive, up-to-date source of information on state, local, utility, and Federal incentives that promote renewable energy and energy efficiency. Established in 1995, DSIRE is an ongoing project of the NC Solar Center and the Interstate Renewable Energy Council funded by the U.S. Department of Energy. The database is located at http://www.dsireusa.org.

Several important decision-making tools to aid in the process of learning about using energy-efficient and solar electric technologies and products are available on the U.S. Department of Energy web site. Available decision making tools include computer software programs that can help analyze the home's energy use and the impact of energy-efficient design features, economics of solar pool heaters, tips of energy savings, etc. http://www1.eere.energy.gov/solar/decision_tools.html.

The U.S. Department of Energy's Solar America Board for Codes and Standards prepared a report of permitting issues titled, "Expedited Permitting Process for PV Systems," which is currently used by jurisdictions throughout California and the United States. The report is located at http://www.solarabcs.org/permitting.

Go Solar California's Clean Power Estimator tool provides potential customers with specific information about available economic incentives and tax benefits of purchasing a solar system. The Clean Power Estimator uses precollected data (electric rate schedules; federal and state income tax rates; federal, state, and utility economic incentives; local weather data; electric load profiles; and PV system performance) to estimate the annual electrical generation municipalities can expect from purchasing a solar system. http://www.gosolarcalifornia.org.

The Solarbuzz global price survey is helpful to monitor month by month the retail price of PV modules and inverters, both in the United States and in Europe. http://www.solarbuzz.com.

Related Strategies

L.2.2 Street Trees
B.1.1 Improve Enforcement of Building Energy Standards
B.1.2 Going Beyond State Building Energy Standards
B.1.7 Shade Trees
C.1.2 Energy District Financing

Endnotes

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RETROFITTING RESIDENCES

Many homes in California were built prior to the enactment of the first California Building Energy Efficiency Standards for new buildings in 1978. Space conditioning and water heating are the two largest categories of energy use, and heating and cooling for these homes can be significantly reduced by retrofits that improve the energy performance of the heating and cooling systems. These retrofits offer major nonenergy benefits including improved comfort, indoor air quality and durability, as well as reduced opportunity for mold and other respiratory irritants.

Research suggests that new homeowners are more motivated to conserve energy than those who have lived in the same house for a long time, but they may not have the necessary capital to invest in energy efficiency measures, even with short payback periods.[1] Because renters often pay the energy bills, rental property owners often have even less motivation to invest in conservation measures referred to as a "split incentive."

Homes built before 1978 have significant potential for energy efficiency improvements. Photo: Local Government Commission.

What is a Home "Retrofit?"

To retrofit means to repair or improve the building envelope and duct systems; correct poorly installed or damaged efficiency measures and install new equipment. Typical home retrofits involve:

- **Reducing drafts with air-sealing;**
- **Adding and improving insulation;**
- **Upgrading heating systems;**
- **Improving indoor air quality through ventilation;**
- **Installing carbon monoxide detectors; and**
- **Replacing plumbing fixtures with high efficiency models.**

This section provides ideas about how local governments can require or incentivize homeowners and landlords to invest in cost-effective improvement upgrades to increase energy efficiency and comfort of their residences.

General Plan Language Ideas

» The City/County shall adopt an ordinance requiring energy ratings and water audits to be performed on residences prior to sale or transfer.

- The City/County shall adopt an ordinance requiring residences to be retrofitted with cost-effective energy and water conservation devices upon resale.
- The City/County shall work with the local electric, gas, and water utilities to develop education and incentive programs, including rebates for homeowners, landlords, and tenants to install cost-effective energy- and water-conserving fixtures and equipment. The objectives of the program will be to retrofit ___ percent of the residential units built before the 1978 Standards with energy conservation measures and ___ percent of all homes with water-conserving fixtures by [year].
- The City/County shall direct the Redevelopment Agency to work with utilities and offer additional incentives to homeowners, landlords, and tenants for retrofitting homes in redevelopment areas with energy- and water-conserving measures. The program's objective will be to retrofit all homes with cost-effective water-conserving fixtures and all homes built before the 1978 Standards with energy-conserving measures by [year].
- The City/County shall investigate establishing an AB 811-type financing program for residents and businesses that will provide low interest financing for energy efficiency upgrades. The loans will be repaid on property tax bills from utility bill savings.

Implementation Ideas

- **Adopt a mandatory rating ordinance.** Prior to resale, an energy rating would be performed on the home and given to the prospective buyer. By doing so, the buyer will be made aware of the energy-efficient features of the home he or she is considering for purchase. The rating should be consistent with the California Home Energy Rating System (HERS) Phase II Program regulations (see below) to include a HERS Index, recommendations on cost-effective measures to improve energy efficiency (including payback periods), and estimates of potential utility bill savings of each recommended improvement. The rating could also include information on utility rebate programs and other incentives. The cost of improvements could be included in the new loan or be reflected in the purchase price.
- **Adopt a retrofit ordinance.** The ordinance could require the retrofit of a dwelling with specified energy and water efficiency devices prior to resale. The ordinance should affect all residences built prior to the 1978 standards for new buildings. Residences built after the standards but prior to changes in the 2005 standards could be included, but with different requirements.
- **Develop education and incentive programs.** While local utilities offer rebates and other programs to encourage people to retrofit their homes, local governments can work with utilities to extend and improve these programs. For example, cities and counties could do the following:
  1. Publicize utility programs;
  2. Integrate electric, water, and natural gas utility programs by organizing combined publicity and "one-stop" centers for information on conservation in city hall or another public location;
  3. Provide additional funding for rebates or free distribution of fixtures, such as compact fluorescent lamp (CFL) bulbs;
  4. Organize workshops or conservation fairs for residents with information from local utilities and products for sale;
  5. Work with utilities to target marketing to owners of older homes, landlords, new homeowners, and owners undertaking renovation projects;
  6. Recognize and present prizes or monetary rewards to residents making exceptional efforts at improving efficiency; and
  7. Develop and distribute a local "Energy Resource Guide."
- **Retrofit homes in redevelopment areas.** Use redevelopment funds to provide improvements targeted to the needs of homeowners, land-

lords, and tenants in redevelopment areas. The program might include rebates (in addition to utility programs), no-interest loans, installation services, and free products (e.g., CFL bulbs and ultra low-flow showerheads). The program could supplement utility incentives and the federal government's Low-Income Weatherization program.

» **Actively promote the use of a home energy rating system.** The California HERS Phase II Program has been established to guide the production of accurate and uniform Whole-House Home Energy Ratings for newly constructed and existing homes based on a single statewide rating scale. A home energy rating system evaluates relative energy performance of a dwelling, assuming typical occupant behavior, so that, much like miles per gallon rating for automobiles, a prospective buyer can compare the energy features of one home with another. For more information, please visit the Energy Commission's HERS web site at http://www.energy.ca.gov/HERS/index.html.

» **Help consumers switch from electric hot water heaters to solar water heating systems.** Check with the local utility to identify customers receiving "all electric" rates. Once these customers are identified, partner with the California Solar Energy Industries Association to convert qualified buildings to solar water heating systems.

Energy Savings

Homeowners can achieve energy savings of 30 percent or more while improving the home's comfort level by adopting energy-efficient building practices and improvements, such as replacing incandescent bulbs with CFL bulbs and adding attic insulation, respectively. Substantial savings can be attained through implementing various energy-efficiency measures, whether the homeowner is building a new home or renovating an existing one. After making all appropriate energy-efficient improvements, homeowners who want even more dramatic reductions in utility bills can install on-site energy production methods, such as passive solar or active photovoltaic systems and other forms of renewable energy.[2]

Studies of retrofits conducted on single-family homes nationwide indicate overall savings of 20-25 percent for packages of measures, primarily insulation. Installing ceiling insulation can reduce space heating energy use by 13-21 percent.[3] Staff from San Francisco estimate savings of 10 percent for residential units subject to the city's mandatory retrofit ordinance. Nationwide data show a median energy savings from retrofitting multifamily residential buildings of 14-16 percent, with energy savings ranging from 10-30 percent for the majority of buildings.[4]

Older, single-family homes that have not been retrofitted use from 5,800-10,000 kWh of electricity and 500-900 therms of natural gas per year. If energy savings per unit averaged 10-30 percent, savings would be 580-3,000 kWh and 50-270 therms per unit per year.[5] Community-wide savings can be estimated based on the percent of buildings retrofitted, average savings, and the percent of overall energy used by those homes. For example, assume that 75 percent of the homes in a city were built before the 1978 efficiency standards and that these homes consumed at least 75 percent of the residential energy in the city. If just 20 percent of the older homes were retrofitted, with energy savings averaging 10-30 percent, overall residential energy consumption would fall 1.5-4.5 percent.

Environmental Benefits

Reducing electricity demand can reduce pollution from power plants. Measures that reduce electricity demand during peak periods, such as more efficient air conditioning or window shading, will be particularly effective in reducing air pollutant emissions, since more polluting power plants are typically used to provide power during peak times.

In 2004, energy-saving measures and energy-efficient homes allowed Americans to cut their energy bills by more than $7 billion and save enough energy to power 15 million homes. The avoided greenhouse gas emissions were equal to removing 14 million cars from our nation's highways.[6]

Economics

The first California Standards and Energy Efficiency Appliances Standards went into effect in the late-1970s. The two sets of standards for buildings and appliances have saved the state more than $56 billion in electricity and natural gas costs since 1978. It is estimated that both standards will save an additional $23 billion by 2013.[7]

Using the energy savings example above, if each home retrofitted saves 580-3,000 kWh of electricity and 50-270 therms of natural gas per year, homeowners will save $130-760 per year.[8] Payback periods for a package of retrofit measures are likely to range from five to nine years. Some measures, such as water heater blankets and ultra low-flow toilets and showerheads, have payback periods of less than a year.[9]

Lowering utility bills may reduce city or county income from utility taxes. However, the money saved by residents can be used to purchase other goods and services in the community, adding to the local economy.

Programs in Operation

The City of **Berkeley** adopted a Residential Energy Conservation Ordinance (RECO) in 1981. The RECO's purpose is to increase the energy and water efficiency in Berkeley residences that will save money, increase the comfort, and reduce the amount of greenhouse gases in every home. Berkeley's RECO applies to all homes, residential areas of mixed-use, tenants-in-common, condominiums, multifamily properties, live-work spaces, and boarding houses. RECO compliance is required when one of the following occurs: the property is sold or transferred; $50,000 or more in renovations are done; or the property owner applies to the Berkeley FIRST financing program (see strategy C.1.2).

Berkeley's RECO has affected 500-600 houses a year. The current program is designed to reduce total residential energy use by 10-20 percent. The City recognized opportunities for deeper energy reductions in the residential section and is in the process of revising RECO to achieve deeper energy savings and avoid lost opportunities. For example, the current RECO requirement for the installation of attic insulation would be replaced with a policy that prioritizes air sealing measures prior to insulation. Berkeley's Climate Action Plan links the voluntary and mandatory energy standards with accepted performance-based standards such as the HERS Phase II for Whole-House Home Energy Ratings. The proposed revisions to Berkeley's RECO shift the requirements from installing individual measures to diagnostic reporting of whole-house performance. Rebate programs for home performance improvement are also under development. Web site: http://www.ci.berkeley.ca.us/ContentDisplay.aspx?id=16030.

San Francisco adopted a RECO in 1982 requiring an energy retrofit upon sale, meter conversion, major renovations, or condominium conversion. In the first 4.5 years, over 24,000 units were retrofitted, representing about 18 percent of the housing stock. The RECO's intent is to improve affordability of housing in San Francisco and to overcome barriers to energy conservation in rental housing. The limit on spending for retrofits is one percent of the sales price up to a maximum of $1,300 for a one- or two-unit building. Web site: http://www.sfgov.org (then type 'residential energy conservation ordinance' in the search box).

The City of **Roseville** mandates homes to have an energy evaluation prior to resale. Each time a house is offered for sale, the seller must either arrange for an energy audit to meet the requirements or demonstrate that the minimum Energy Conservation Standards (e.g., attic space, domestic waterheaters, pipes, plumbing fixtures, ductwork, windows, and doors) have been met. http://qcode.us/codes/roseville/view.php?topic=16-16_18-16_18_030&frames=on.

Resources

Public Resources Code Section 25942 requires the California Energy Commission to adopt a statewide **HERS Program** for residential dwelling and certifying home energy rating services in California. The goal of the program is to provide reliable information to differentiate the energy efficiency levels among California homes and to guide investment in cost-effective home energy efficiency measures.

The California HERS Phase I Program includes field verification and diagnostic testing available through Energy Commission-approved providers and a process for certifying HERS raters who perform third-party quality assurance verifications. Under the HERS Phase II regulations, the Energy Commission anticipates that in late 2009, the program will be expanded to include whole-house home energy efficiency ratings for existing and newly constructed homes. Web site: http://www.energy.ca.gov/HERS/index.html.

California's electric and gas utilities offer information, trainings, and equipment demonstrations at their energy resource centers to help customers make informed energy decisions. Visit their web sites for more information.

- » PG&E's Pacific Energy Center and Stockton Training Center: http://www.pge.com/pec.
- » Sacramento Municipal Utility District: http://www.smud.org/en/education-safety/Pages/index.aspx.
- » Southern California Edison's Customer Technology Application Center (CTAC) and Agricultural Technology Application Center (AGTAC): http://www.sce.com/b-sb/energy-centers.
- » Southern California Gas Company's Energy Resource Center: http://www.socalgas.com/business/resourceCenter/ercOverview.html.

The California Solar Energy Industries Association (CALSEIA) supports the widespread adoption of solar thermal and solar photovoltaic systems. Companies that join CALSEIA are doing business in California or supplying products to California companies. CALSEIA works to ensure safety, reliability and standardization of requirement for solar installations. Web site: http://calseia.org.

Related Strategies

B.1.5	Retrofitting Commercial Buildings
B.1.2	Going Beyond State Building Energy Standards
C.1.2	Energy District Financing

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RETROFITTING COMMERCIAL BUILDINGS

Commercial enterprises use 37 percent of the electricity consumed in California.[1] Adopting an ordinance that requires an energy and water use audit and/or retrofit upon resale can reduce energy and water consumption. Local governments also can work closely with utilities to develop a comprehensive retrofit program.

Energy and water audits will identify the systems with the most potential for savings; those systems will vary by business type. Typically, replacing older fluorescent light fixtures with more efficient lamps and ballasts is an easy and cost-effective upgrade. Old boilers and chillers or other heating, ventilation, and cooling equipment are also candidates for replacement – but generally not as cost effective.

This section provides ideas for how local governments can encourage retrofits of commercial buildings in order to reduce their energy use.

Fluorescent lighting upgrade.
Photo: San Mateo County.

General Plan Language Ideas

» The City/County shall adopt an ordinance requiring an energy and water audit of commercial buildings upon resale.

» The City/County shall adopt an ordinance requiring energy efficiency and water conservation improvements in commercial buildings upon resale.

» The City/County shall consult with and help organize local electric, gas, and water utilities to develop a comprehensive technical assistance and incentive program encouraging existing commercial building owners to install energy and water conserving fixtures and equipment. The objective of the program is to retrofit __ percent of the commercial space built before 1978 by [year].

Implementation Ideas

» **Adopt a resale retrofit ordinance.** The ordinance could require:

- An energy and water audit, with recommendations for retrofit measures, to be given to the buyer;

- The retrofit of specific, prescribed energy and water conservation measures listed in an ordinance;
- Retrofit measures with a reasonable payback period, as determined by an audit or modeling; and
- Retrofit measures that lead to overall energy and water consumption within a specified energy and water budget (a performance-based approach).

The ordinance could apply upon transfer of title, when a permit is issued for expansion or major renovation, by a "date certain" (e.g., 10 years from passage of ordinance), and/or upon a change in the service connection.

» **Establish a technical assistance and incentives program with local utilities.** Electric and gas utilities have rebate and/or technical assistance programs for businesses. Local governments could be the catalyst for developing more comprehensive programs by:

- Helping to integrate water conservation programs;
- Providing information with business license applications;
- Providing information and assistance when reviewing permits for renovations and additions; and
- Organizing workshops and exhibits to bring together local businesses, utilities, equipment suppliers, and installation contractors.

Energy Savings

Audits performed for the California Energy Commission's Energy Partnership Program and Bright Schools Program throughout California found that the average estimated savings was 13 percent with an average estimated payback period of 6.4 years.[2] Offices experienced an average estimated electricity savings of 0.21 kWh per sq. ft. (21 percent) and an average estimated energy dollar savings of $0.18 per sq. ft (18 percent). Schools experienced an average estimate of 0.17 kWh per sq ft. (17 percent) in electricity savings and an average estimate of $0.17 per sq. ft. (17 percent) in energy dollar savings. Other building types experienced electricity savings of 0.18 kWh per sq. ft. (18 percent) and energy dollar savings of $0.12 per sq ft (12 percent).

Statewide, commercial buildings consume about 14 kWh of electricity and 26,000 BTUs of natural gas per square foot per year.[3] If savings ranged from 5-20 percent, 70,000-280,000 kWh and 130-520 million BTUs would be saved annually per 100,000 square feet of commercial space retrofitted.

Water savings of around 30 percent are feasible in most commercial and industrial buildings.[4] While some water-conserving equipment may use electricity, energy savings will result from the reduction in water heating, pumping and wastewater treatment.

Environmental Benefits

Reducing the amount of electricity a building uses will reduce air pollutants from power plants. Exact emission reductions will depend upon the source of electricity. Higher polluting power plants are often used only when electricity demand peaks during daytime hours. If commercial retrofit measures result in savings during these peak periods, air quality benefits are maximized. Such reductions will help regions meet strict state and federal air quality standards. Reducing natural gas use will reduce on-site air emissions.

Economics

Renovations and retrofits that replace older systems with more efficient technology in existing buildings can reduce a business' energy costs by as much as 30 percent.[5]

Building owners or tenants will incur capital costs to install retrofit measures. However, if the retrofit program or ordinance requires only measures that are cost-effective, expenditures will be paid back within a reasonable time as a result of annual energy and water cost savings. In addition, a retrofit ordinance can include a cap on total expenditures. Annual savings can then be reinvested in the business and the local economy, rather than spent on energy. To the extent that retrofits are performed by local businesses, dollars are invested in the local economy.

The median cost of commercial building retrofits examined in the study cited in the "Energy Savings" section was $1.01./sq. ft. (2009 dollars), with a median payback period of 3.1 years. Costs were lowest for retail buildings ($0.65/sq. ft., 1.0 year payback) and highest for health-related and other buildings ($1.99/sq. ft., 5.9 and 7.1 year paybacks). The median cost for office buildings was $1.46/sq. ft., with a median payback period of 2.6 years.

Programs in Operation

Many local governments, working in partnership with their utilities, have implemented energy efficiency programs for businesses, especially small businesses that are more numerous and difficult to reach than larger ones. Absent such partnerships, local governments can help refer commercial property owners to the rebates and technical assistance offered through the utilities.

In 1996, **San Francisco** repealed its Commercial Energy Conservation Ordinance (CECO) that had been in effect since 1989 because it was unpopular and difficult to enforce. As of spring 2009, the city had proposed a commercial and multifamily linear fluorescent lighting ordinance that had the support of the Building Operators and Managers Association, Apartment Owners Association, Small Business Commission and the Building Inspection Commission. The ordinance would encourage nonresidential building owners to upgrade existing lighting with more efficient and low-mercury alternatives. It would only affect lamps installed after 2010. The ordinance will apply to city buildings as well.

The City of **Berkeley** adopted a CECO in 1994. It requires commercial property owners to complete certain energy conservation measures upon transfer or property ownership or when additions or remodels costing $50,000 or more are made. CECO is also triggered if a property owned applies to the Berkeley FIRST financing program (see Strategy C.1.2). http://www.ci.berkeley.ca.us/ContentDisplay.aspx?id=15474.

Resources

Flex Your Power (www.fypower.org) is a partnership of California's utilities, residents, businesses, institutions, government agencies, and nonprofit organizations working to save energy. The web site offers Best Practice Guides that building owners and managers can use to save energy and money, including a guide for hotels; a guide for restaurant owners and managers; food growers and beverage processors; and commercial office building owners.

California utilities also offer a multitude of programs to help businesses (and residents) reduce their energy use, as well as information, trainings, and equipment demonstrations at their energy resource centers to help customers make informed energy decisions. Visit their web sites for more information:

- PG&E: http://www.pge.com.
- San Diego Gas & Electric: http://www.sdge.com.
- Southern California Edison: http://www.sce.com.
- Southern California Gas Company: http://www.socalgas.com.
- Sacramento Municipal Utility District: http://www.smud.org.

Some nonprofit or joint powers agencies, such as the California Center for Sustainable Energy (www.sdenergy.org), Redwood Coast Energy Authority (www.redwood-energy.org), and the Ventura County Regional Energy Alliance (www.vcenergy.org) offer similar energy centers. Some councils of government have energy programs as well, including ABAG, AMBAG, San Gabriel Valley COG, and South Bay Cities COG.

California SAFE-BIDCO serves statewide as a nontraditional financing source for small businesses. Created by the California legislature, SAFE-BIDCO offers low interest loans for programs supporting energy conservation. http://www.safe-bidco.com.

Related Strategies

B.1.4 Retrofitting Residences
B.1.6 Efficient Lighting
C.1.2 Energy District Financing

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EFFICIENT LIGHTING

Artificial lighting represents almost 15 percent of a household's electricity use. Use of low-energy lighting technologies can reduce lighting energy use in homes by 50-75 percent. Lighting energy use can be reduced by selecting lighting and sources that use energy more efficiently, installing lighting controls such as occupancy sensors, and making better use of natural daylight to reduce the need for artificial lighting.[1]

Artificial lighting also represents a significant fraction – about 38 percent on average – of electricity use in commercial buildings.[2] Beginning with the 2005 update of California's Title 24 Standards, lighting for nonconditioned spaces, and exterior lighting of commercial buildings, are required to comply with the energy Standards. The Standards also require that all installed lighting controls (dimmers, motion sensors), and skylights in most big box stores and warehouses be checked to ensure properly installed and are operating according to specifications. Because of these requirements, new building lighting should be very efficient. More effort will be needed, however, to upgrade lighting in existing commercial buildings.

The following are ideas for how local governments can encourage the use of energy-efficient lighting.

General Plan Language Ideas

» All new City/County buildings shall include lighting systems using less energy than state standards in place at the time of adoption. New buildings shall incorporate daylighting.

» In cooperation with the local electric utility, the City/County shall provide incentives and information to residents and businesses to encourage replacement of existing lighting with more efficient fixtures and technologies.

» The lighting systems in all City/County buildings shall be audited with respect to energy use and retrofitted with more efficient fixtures and technologies. All buildings should be retrofitted by [year].

» The City/County shall develop a program to improve the lighting efficiency of existing commercial buildings in its jurisdiction, providing incentives to building owners.

Implementation Ideas

» Work with your local utility to offer technical assistance and incentives to encourage retrofit of existing buildings.

» Include lighting in residential and commercial retrofit ordinances (see strategies B.1.4 Retrofitting Residences and B.1.5 Retrofitting Commercial Buildings).

» Perform a comprehensive energy analysis of all municipal buildings and develop a retrofit program. Pursue funding from the existing budget, utility rebates, loans from the California Energy Commission, and other sources.

Examples of Energy Efficient Lighting Technologies

Compact fluorescent light bulbs and light emitting diode (LED) lights. Both of these technologies reduce energy consumption by about 75 percent compared to standard incandescent lighting. Compact fluorescent bulbs are increasingly used in residential as well as commercial applications, while LED lights are especially well-suited to commercial settings. Only pin-based CFLs that plug into luminaires with integrated ballasts meet Title 24 standards. Screw based bulbs which may later be replaced by less efficient incandescent ones do not.

Daylighting is the use of windows and skylights to bring sunlight into a building. Today's highly energy-efficient windows, as well as advances in lighting design, reduce the need for artificial lighting during daylight hours without causing heating or cooling problems. (http://www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12290)

Light tubes are a type of skylight used for transporting or distributing natural light. A tube lined with highly reflective material directs the light rays through a building, starting from an entrance-point located on its roof or one of its outer walls. Light transmission efficiency is greatest if the tube is short and straight. In longer, angled, or flexible tubes, part of the light intensity is lost.

A light shelf is an architectural window element that allows daylight to penetrate deep into a building. This horizontal light-reflecting overhang is placed above eye level and has a high-reflectance upper surface. This surface is then used to reflect daylight onto the ceiling and deeper into a space, reducing the need for artificial lighting.

Energy Savings

Artificial lighting consumes almost 15 percent of a household's electricity use. Use of new lighting technologies can reduce lighting energy use in homes by 50-75 percent, reducing total electricity use by about 8-12 percent. An ENERGY START compact fluorescent lightbulb uses 75 percent less energy and lasts about 10 times longer than an incandecent bulb.[3] Lighting energy use can be reduced by selecting lighting and sources that use energy more efficiently and by installing lighting controls.[4]

While many commercial buildings already use more efficient fluorescent lighting, there is still significant potential for reducing energy use. ENERGY STAR qualified lightemitting diode (LED) lighting uses as much as 75 percent less energy and lasts significantly longer than incandescent lighting.[5] In addition, cooling demand will be reduced in a building with more efficient lighting because less heat is produced. Reducing lighting wattage in a commercial building by 50 percent can reduce cooling demand by about 19 percent.[6]

Environmental Benefits

Nationwide, if all commercial buildings installed state-of-the-art energy-saving lighting systems, their lighting energy use could be reduced by at least 40 percent. Doing so would lower U.S. carbon dioxide emissions by about 175 billion pounds per year.[7]

The 16th and Mission BART Station in San Francisco saves almost 790,000 kilowatt hours per year with this lighting retrofit.
Photo: Association of Bay Area Governments Energy Watch Program.

Incandescent and compact fluorescent light bulbs.
Photos: stock.xchng, Incandescent – sxc.hu/aarenyes; CFL – sxc.hu/brokenarts.

If every American home replaced their five most frequently used light fixtures or the bulbs in them with compact-fluorescent bulbs that have earned the U.S. EPA's ENERGY STAR label, the nation would reduce greenhouse gas emissions equivalent to the emissions from nearly 10 million cars.[8]

Economics

An ENERGY STAR qualified compact fluorescent light bulb will save about $30 over its lifetime and pay for itself in about six months. If every American home replaced just one incandescent bulb with an Energy Star compact-fluorescent bulb, we would save $600 million each year in energy costs.[9]

Mount Sinai Medical Center in New York recently replaced standard fluorescent tubes and incandescent lamps in one of its facilities with high-efficiency fluorescent lamps, electronic ballasts, and new reflectors. As a result, lighting energy use in the one million square foot facility was cut almost in half, saving $485,000 per year and yielding a 45 percent annual return on a $1,086,000 investment.[10]

Programs in Operation

The **California Department of Education** Headquarters in Downtown Sacramento employs many innovative lighting techniques. Exterior Low-E glazing was chosen to maximize incoming daylight, while insulating against heat and cold. Closed offices were placed in the center of the building (not at the windows) and light colored walls and furnishings allow daylight to penetrate further from the windows. Perimeter dimming controls lower artificial lighting when there is a lot of sunlight. Closed rooms and workstation power strips have motion sensors, and suspended lighting is projected up to reflective ceiling tiles. The building has many other environmental and energy systems that helped it earn a LEED Gold rating. http://www.documents.dgs.ca.gov/green/factsheets/EducBldgTour.pdf

The City of **San Diego**'s Ridgehaven office building is another example of a building that accrues substantial energy savings through innovative lighting techniques. The city estimated a net reduction of about 52 percent in watts per square foot over what was allowed by the California building code for this type of office structure at the time it was retrofit. In addition to increasing occupant comfort, the lighting design will provide ongoing net savings for 10-20 years after the initial payback period of 3-5 years. Lighting features include: T-8 fluorescent lamps, electronic dimming ballasts, parabolic fixtures with reflectors, room occupancy sensors, daylight sensors in perimeter rooms, work station task lights, and solar control window film for exteriors. http://www.sandiego.gov/environmental-services/geninfo/ridgehaven/index.shtml

The City of **Santa Monica**'s Green Building Program includes suggestions for efficient lighting equipment and use of daylighting in various commercial situations. http://smgreen.org/Content/electricalsys/electricalintro.html

As of spring 2009, **San Francisco** had proposed a commercial and multifamily linear fluorescent lighting ordinance that had the support of the Building Operators and Managers Association, Apartment Owners Association, Small Business Commission and the Building Inspection Commission. The ordinance would encourage nonresidential building owners to upgrade existing lighting with more efficient and low-mercury alternatives. It would only affect lamps installed after 2010. The ordinance will apply to city buildings as well. http://www.sfgov.org/site/uploadedfiles/bdsupvrs/committees/materials/090584tdr.pdf

Community Energy Services Corporation (CESC), a 501 c) 3, has been delivering community based services focused health, safety, and energy conservation to the City of Berkeley since 1986. CESC specializes in helping small and medium-sized businesses meet their energy savings and climate protection goals. CSEC partners with local governments, utilities, and business associations to provide programs and services to businesses throughout Northern California. Since 1999, CESC has audited over 5,000 businesses and helped nearly 3,000 of those businesses improve their operations and reduce their greenhouse gas emissions by approximately 6,000 tons of CO2 per year. http://www.ebenergy.org

Fluorescent tubes.
Photo: iStockphoto.com/stocksnapper.

Resources

The California Energy Commission's **Energy Partnership Program** provides audits, training, and loans to local governments for energy efficiency projects. http://www.energy.ca.gov/efficiency/partnership

California SAFE-BIDCO offers low interest loans for energy conservation programs for small businesses. http://www.safe-bidco.com

The **U.S. Department of Energy** has two web-based home-energy calculators that can be used to gauge a home's energy efficiency.

The ENERGY STAR® Home Energy Yardstick provides a quick measure of a home's energy efficiency. It requires basic information: the homeowner's ZIP code, the size of the house, the year it was built, and utility bill information. Once this information is entered, the energy calculator shows how a home performs on energy use relative to comparable homes in the same location. Then, based on the home's performance, a set of recommendations are provided for improving the home's energy efficiency and lowering utility costs. http://www.energystar.gov/index.cfm?fuseaction=HOME_ENERGY_YARDSTICK.showGetStarted.

A second tool, the Home Energy Saver, offers a more detailed approach and allows the homeowner to estimate the energy- and money-saving impact of implementing various energy-saving improvements. Homeowners can begin the process by simply entering their ZIP code and receive instant initial estimates. The homeowner can receive increasingly customized results and energy-saving recommendations by providing additional information about the home. http://hes.lbl.gov

California's electric and gas utilities offer information, trainings, and equipment demonstrations at their energy resource centers to help customers make informed energy decisions. Visit their websites for more information on the resource centers and for rebates and incentives to improve lighting efficiency and performance.

» PG&E's Pacific Energy Center and Stockton Training Center: http://www.pge.com/pec

» Sacramento Municipal Utility District: http://www.smud.org/en/education-safety/Pages/index.aspx

» Southern California Edison's Customer Technology Application Center (CTAC) and Agricultural Technology Application Center (AGTAC): http://www.sce.com/b-sb/energy-centers

» Southern California Gas Company's Energy Resource Center: http://www.socalgas.com/business/resourceCenter/ercOverview.html

Most municipal utilities offer rebates and/or technical assistance for energy efficiency retrofit projects. Rebates are one method to help finance energy efficiency projects.

The **Lighting Research Group** at Lawrence Berkeley National Laboratory performs research aimed at improving the energy efficiency of lighting systems in buildings and homes. The group's goal is to reduce lighting energy consumption by 50 percent over 20 years by improving the efficiency of light sources, and controlling and delivering illumination so that it is available, where and when needed, and at the required intensity. Research in the Lighting Group falls into three main areas: Sources and Ballasts, Light Distribution Systems, and Controls and Communications. http://lighting.lbl.gov

The **Electric Power Research Institute** researches and provides information on various efficiency measures, including lighting. http://my.epri.com

The *Advanced Lighting Guidelines: 2003 Edition* includes instructional graphics and lighting design solutions for many typical building or space types, including private offices, open offices, conference rooms, grocery stores, big box retail, specialty/boutique stores, classrooms, and gas station canopy lighting. http://www.newbuildings.org/lighting.htm

The **Illuminating Engineering Society** (IES) is the recognized technical authority for the illumination field and provides numerous references and application handbooks. Local chapters of IES periodically hold classes in lighting design fundamentals. http://www.ies.org.

Related Strategies

B.1.2 Going Beyond State Building Energy Standards
B.1.4 Retrofitting Residences
B.1.5 Retrofitting Commercial Buildings
C.5.2 Municipal Facilities

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SHADE TREES

Effective selection and placement of trees and shrubs can reduce air conditioning needs in the summer and heating needs in the winter. Over one half a home's heat gain in the summer comes through south and west facing windows. Deciduous plants can block about 80 percent of the available summer radiation and drop their leaves to permit needed sunshine during cooler months. Trees also reduce CO_2 buildup, increase property values, and enhance community aesthetics.

General Plan Language Ideas

» The City/County shall adopt an ordinance that requires developers of new buildings to plant trees and shrubs to improve energy efficiency and to preserve existing trees on building sites.

» The City/County, in cooperation with the utility, will promote tree planting and landscaping for energy efficiency in existing homes and businesses through education and incentive programs.

» New and renovated landscaping at all City/County buildings shall be designed and maintained to maximize energy efficiency and minimize water use.

Implementation Ideas

» Adopt landscaping requirements for new buildings to promote energy efficiency. Requirements could be integrated into the water conservation landscape ordinance required under AB 325 (see strategy W.2.1 Water Efficient Landscaping). The International Society for Arboriculture publishes guidelines for developing a tree ordinance.[1]

» Publish and/or distribute brochures describing how to plant trees and shrubs to reduce energy demand.

» Provide incentives to plant trees. Start a program authorizing the city/county to plant trees on private property, at the request of the landowner.

» Work with community groups. Local groups, such as affiliates of Global ReLeaf, TreePeople, garden clubs and other nonprofit tree organizations can help organize activities.

» Plant trees and shrubs around new and existing local government buildings.

» Establish design criteria for new local government buildings to maximize energy savings through landscaping.

Energy Savings

In a warm climate, strategically planted trees and shrubs can cut summer cooling needs. Trees cast maximum shadows when planted on the west and south sides of a house, while shrubs planted on all sides help reduce the temperature of the soil and walls. Planting trees just to shade a building's air conditioner can increase its efficiency during the warmest periods. Proper pruning and the use of deciduous trees on the south side can allow winter sun to warm homes. In areas with cold winter winds, evergreen and coniferous trees and shrubs can form windbreaks and help reduce heating needs.

A well-planned landscape can reduce an unshaded home's summer air-conditioning costs by 15-50 percent. One Pennsylvania study reported air-conditioning savings of as much as 75 percent for small mobile homes.[2]

The National Renewable Energy Laboratory of the U.S. Department of Energy found that carefully positioned trees can save up to 25 percent of a household's energy consumption for heating and cooling. Computer models devised by the U.S. Department of Energy predict that the proper placement of only three trees will save an average household between $100 and $250 in energy costs annually. On average, a well-designed landscape provides enough energy savings to return the initial investment in less than eight years.[3]

Planting trees can also help reduce the effect of summer heat islands, thereby reducing air conditioning needs. Shading and evapotranspiration (the process by which a plant actively moves and releases water vapor) from trees can reduce surrounding air temperatures as much as 9°F (5°C). Because cool air settles near the ground, air temperatures directly under trees can be as much as 25°F (14°C) cooler than air temperatures above nearby blacktop. Studies by the Lawrence Berkeley Laboratory found summer daytime air temperatures to be 3°F to 6° F (2°C to 3°C) cooler in tree-shaded neighborhoods than in treeless areas.[4]

Trees, fences, or geographical features can be used as windbreaks to shield a house from the wind. A study in South Dakota found that windbreaks to the north, west, and east of houses cut fuel consumption by an average of

The parking lot on the top contributes more to the urban heat island effect than the one on the bottom.
Photos: Local Government Commission.

40 percent. Houses with windbreaks placed only on the windward side (the side from which the wind is coming) averaged 25 percent less fuel consumption than similar but unprotected homes. In a windy climate, well-planned landscape can reduce winter heating bills by approximately one-third.[5]

Environmental Benefits

California's peak electricity use comes on hot summer afternoons. During those peak events, the least efficient and dirtiest power plants are fired up to meet demand. Reducing the need for air conditioning will correspondingly reduce the need for electricity from these dirty plants. Reducing energy demand during peak periods also may delay the need for additional generating capacity and, perhaps limit construction of new power plants. The impact of plant construction and power line transmission may therefore be avoided.

According to several studies, trees and other vegetation play an important role in absorbing nitrogen dioxide, sulfur dioxide, ozone, hydrogen fluoride, and chlorine.

Species with smaller, rougher leaf surfaces remove particulates best, while in winter conifers work very well. Drought-resistant species tolerant of urban conditions filter gaseous pollutants best.

Preserving existing trees will help maintain animal habitats, increase the stability of soils, and reduce erosion.

Economics

The cost of enforcing a mandatory tree ordinance depends upon the number of building permits issued. However, verifying that trees included in plan proposals are planted at building sites should add only minimal time to the plan and building review process.

The Center for Urban Forest Research (CUFR) studied the effects of shading on pavement in Modesto, California. It found that unshaded streets required six resealing applications over 30 years, while a street lined with large shade trees required only two and one half over the same amount of time. CUFR estimated that the shade from the large trees would save 66¢ per square foot over the 30-year period. That's $23 per linear foot for a 35-foot wide street, or $122,000 per linear mile.[6]

Shaded streets require repaving less often.
Photo: Local Government Commission.

In 2001, CUFR estimated the average annual value over 20 years of benefits from one large tree shading the western wall of a home in the Inland Empire to be $78; in the San Joaquin Valley the same benefit was $65. The benefits measured include reduced electric cost, carbon sequestration, air pollution reduction, rainfall interception, and property values. Costs included purchase, planting, pruning, irrigation, infrastructure repair, and removal and disposal.[7]

Funding Sources

» Local utilities.

» Fines from improper removal of trees under a tree protection ordinance.

» Developer fees.

» Assessment districts.

» State and Federal grants (see "Resources").

Programs of Operation

Since 1990, the **Sacramento Municipal Utility District** (SMUD), in collaboration with the **Sacramento Tree Foundation,** has planted more than 400,000 trees in the Sacramento area. SMUD provides expert advice on tree selection and planting techniques and healthy trees from 4 to 7 feet tall, along with stakes, ties, fertilizer, and tree delivery at no cost to customers with an eastern, western or southern exposure that heats up during the summer.

SMUD developed a Tree Benefit Estimator© based on the experience of the SMUD's Shade Tree program. The Tree Benefit Estimator can be used by those who have no formal background in urban forestry or Demand Side Management (DSM) utility practices. The tool incorporates assumptions regarding trees' impact on direct shading benefits, impacts of indirect or evapotranspiration effects, heating penalties in winter months, tree growth rates and tree survival rates. http://www.smud.org/en/residential/trees/Pages/tree-benefits-estimator.aspx#top

The City of **Davis** Urban Forestry Program officially began in 1963 with the establishment of the Street Tree Committee. Prior to 1963, developers were encouraged to plant a tree in the parkway in subdivisions. The program's initial purpose was to provide shade and aesthetics for the community, which remains the primary concern. Through the years, the program has evolved to include:

» A Master Tree List;

» A tree planting program;

» A tree maintenance program;

- A tree inventory;
- The Tree Commission; and
- An informed and supportive public.

Currently, the city maintains about 13,000 street trees, and over 5,000 trees in parks and greenbelts. It also requires new parking lots, and those undergoing remodeling, to develop a plan for shading 50 percent of the lot within 15 years. Concerned residents help the city to ensure its tree program is properly implemented. http://davispd.org/pgs/trees/index.cfm

Pasadena Power and Water offers residential electric customers a rebate for planting any one of 37 species of shade trees under its Cool Trees Program. Planting deciduous (shade) trees around a property can reduce the amount of energy used for cooling in the summer, while letting in the sun's warming rays during winter. In addition to their energy saving benefits, trees provide privacy, prevent soil erosion, and beautify your environment. Rebates range from $40 to $60 per tree. http://ci.pasadena.ca.us/waterandpower/cooltrees/default.asp

Resources

The mission of the California Department of Forestry and Fire Protection's Urban Forestry Program is to develop a regional and statewide cooperative effort to advance development of sustainable urban and community forests. The Urban Forestry Program offers grants of over $1 million dollars a year to plant trees and over $2.5 million for related projects in urban communities throughout California. Urban Forestry Field Specialists provide expert urban forestry support to communities, nonprofit groups and other municipal governments to create and maintain sustainable urban forest. http://www.fire.ca.gov/resource_mgt/resource_mgt_urbanforestry.php

The Center for Urban Forest Research provides reliable scientific evidence that urban forests add real value to communities. Their research is available through publications and assistance tools. The Center offers a tree carbon calculator or California climate regions. It also developed the Urban Forest Project Reporting Protocol for the California Climate Action Registry. http://www.fs.fed.us/psw/programs/cufr

California ReLeaf works statewide to promote alliances among community-based groups, individuals, industry, and government agencies, encouraging each to contribute to the livability of cities and the protection of the environment by planting and caring for trees. California ReLeaf also serves as the state's volunteer coordinator for urban forestry in partnership with the California Department of Forestry and Fire Protection. http://www.californiareleaf.org

Cooling Our Communities: A Guidebook on Tree Planting and Light-Colored Surfacing, by the U.S. EPA and Lawrence Berkeley Laboratories, is an excellent source of information for local governments on the benefits, costs, and issues involved in tree planting. The guidebook includes a Comprehensive Model Energy Conservation Landscaping Ordinance that includes requirements for minimum landscape standards and tree preservation. http://eetd.lbl.gov/EA/1995_Ann_Rpt/Buildings/cooling.our.html

TreePeople is a nonprofit organization that has been serving the Los Angeles area for over three decades. They offer sustainable solutions to urban ecosystem problems, focusing on three areas: training and supporting communities to plant and care for trees; educating school children and adults about the environment; and working with government agencies on critical water issues. http://www.treepeople.org

Related Strategies

L.3.2	Street Trees
W.2.1	Water Efficient Landscaping

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ENERGY AWARE PLANNING GUIDE

INTRODUCTION

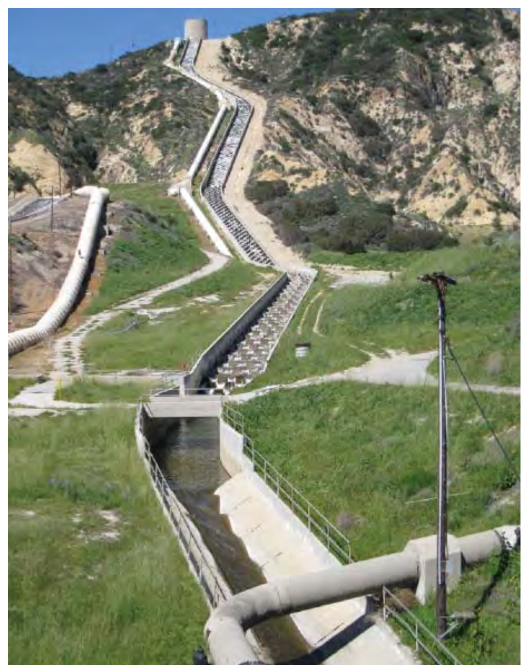
WATER USE STRATEGIES

The water sector is the largest user of energy in California, accounting for nearly 20 percent of all electricity consumed in the state. About 75 percent of that energy is consumed by end users, the other 25 percent is used for supply, treatment before use, and wastewater treatment.[1]

The energy used for pumping water will depend upon the source (e.g., surface or groundwater) and the distance. For example, pumping an acre-foot of water (325,900 gallons) to southern California through the State Water Project system uses about 1,750 kWh of electricity.[2]

According to the Pacific Institute, water conservation is the cheapest and most readily available option to increase California's water supplies. The Institute's 2005 report, *Waste Not Want Not*, highlights the potential for water efficiency to cost effectively increase water supplies by decreasing demand. More than one half of urban water conservation strategies can be achieved at $200 per acre-foot or less. The report estimated that urban water conservation could contribute 2.0 to 2.3 million acre-feet per year to California's water supplies – enough to supply the current demands of more than two million households.[3]

Climate change will affect California's water supplies and quality. California depends on the snowpack in the Sierra Nevada Mountains as a massive natural storage system. Climate change experts warn that shorter winters and higher temperatures will decrease the Sierra snowpack by



California Aqueduct crossing the Tehachapi Mountains.
Photo: Aquafornia.

as much as 70-90 percent by the end of the century, effectively shrinking California's largest water storage system.[4] Conjunctive use, storing large volumes of surface water underground during normal and high rainfall years, and then pumping from underground storage during drought years is another potential source of water supply.

California is a vast state. Rural areas and coastal urban areas cannot be held to the same water standard, as the lack of economy of scale for small communities reduces cost effectiveness. This holds true for conservation, recycling, and water supply and treatment programs. Inland and coastal areas may share the same watershed, however, and have vested interests in each others' actions.

More efficient and sustainable water management solutions, with less economic and environmental costs, are needed. This shift will rely in part on expanded use of efficiency measures including conservation practices, recycling and reuse, and water capture systems; these combine to increase water supplies.

Energy and Water Use

Energy and water use are linked in three ways:

1. **Water pumping and purification:** The amount of energy used to pump water will depend upon the source (e.g., surface versus groundwater), the height the water must be raised the distance, and the treatment plant pressure requirements.

2. **Wastewater treatment:** Energy consumption in most wastewater treatment plants ranges from 1,000 to 2,400 kWh of electricity per million gallons (mg) of wastewater treated.[5] However, these plants can also generate energy.

Water treatment plant pumps.
Photo: City of Ventura.

3. **Water heating:** In an average home, 41 percent of the water is used for dishwashing, faucets, laundry, and bathing water that is often heated.[6]

Of the water delivered to urban areas, 66 percent is used in residences, 37 percent by commercial and industrial users, and seven percent by large landowners. For residential users, both single and multifamily, over one half is used for outside landscaping and other outdoor uses.[7]

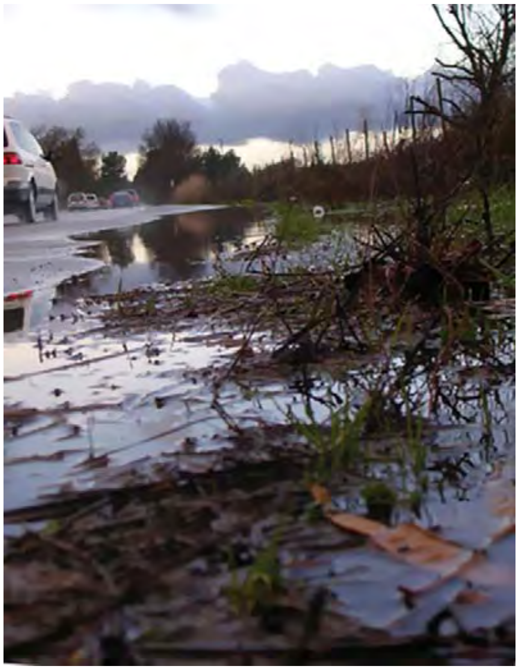
Saving Energy through Saving Water: Local Government's Role

Conserving water results in energy savings not only at the point it is used (mostly for heating), but also in reducing requirements for water pumping and purification, and wastewater treatment. Local governments can promote water conservation in cooperation with wholesale and retail water agencies. They can also be instrumental in reducing water system demands by improving zero discharge designs, developing onsite renewable resources such as biogas at wastewater treatment sites, and other infrastructure improvements.

Compact development reduces costs and energy by requiring less pressure (energy) for delivery, and requiring shorter delivery pipes, which result in a 6-25 percent reduction in loss through leakage.[8] Using water more than once before releasing it back into rivers and streams reduces energy use for treatment and pumping. Programs can be adopted to improve water use efficiency in landscaping. Expediting the deployment of meters, requiring more efficient fixtures and appliances (like ultra low flow toilets and low water using clothes washers), and using conservation pricing are other efficiency measures that local governments can employ. The California Urban Water Conservation Council has best management practices to guide water agencies.

Water conservation and reuse also help local governments, water agencies, and developers meet California's "show me the water" laws, which require identification of a sufficient supply of water before approving development projects with 500 or more residential units. Urban Water Management Plans are also assisting in better water planning.

Water agencies need to better explain the value of water. Water rate structures play a critical role in conveying that value to consumers. They also reflect the hidden costs of developing and providing water to a growing population.



Stormwater runoff contains pollutants from cars.
Photo: Local Government Commission.

Consumers who use more water or locate in areas that are harder to serve should pay more for water delivery and wastewater treatment. In addition, other costs of providing water services to consumers need to be included in the price of water, such as conservation and education programs, infrastructure upgrades and efficiency improvements, and research.

Stormwater has become an energy issue for more local governments since the U.S. Environmental Protection Agency's National Pollutant Discharge Elimination System instituted a permit requirement for municipal separate storm sewer systems. This has reduced the threshold for compliance to communities of 10,000. Reducing the amount of stormwater that runs off properties into sewer systems, or eliminating pollutants that make their way into stormwater, will reduce the costs associated with treating it.

The list of water policies included in the Guide appear below. Policies that appear in other sections of the Guide which also reduce water-related energy consumption appear in italics. These policies are a small fraction of what can be adopted. Several water agencies and local governments have endorsed a list of best management practices for water conservation that can be used as a starting point for additional local programs (see Background: Urban Water Conservation).

For additional information contact:
California Department of Water Resources,
Office of Water Use Efficiency and Transfers
901 P Street, Third Floor
Sacramento, CA 95814
www.owue.water.ca.gov

Water Strategies

W.1.1 Stormwater Reduction
W.2.1 Water Efficient Landscaping
W.2.2 Water Conservation Pricing
W.3.1 Water Reuse and Recycling
W.4.1 Efficient Wastewater Treatment

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URBAN WATER CONSERVATION

In 1991, many urban water suppliers, public advocacy organizations, and other interested groups entered into a "Memorandum of Understanding (MOU) Regarding Urban Water Conservation in California." The MOU was the result of two years of negotiation and commits the signatory water suppliers to implement a list of "best management practices" (BMPs) for water conservation in California's urban areas.[1]

The BMPs are intended to reduce long-term urban water demands. Other measures are available for implementation during water shortages that would yield additional savings. In addition, the signatories recognized that there may be additional measures to reduce long-term water needs. For each BMP, the MOU includes a description, implementation schedule, and assumptions for estimating water savings.

The MOU has been updated 14 times since it was originally adopted. During 2008, the BMPs were updated to include current technology and credit agencies for their innovative water conservation programs.

Adopted Best Management Practices

Water Utility Operations:

1.1 Operations Practices:

Conservation coordinator: Designate a conservation coordinator for program management, tracking, and reporting on BMP implementation.

Water waste prohibition: Enact, enforce, or support legislation, regulations, ordinances, or terms of service.

Wholesale agency assistance programs: Develop assistance relationships between regional wholesale agencies, intermediate wholesale agencies and retail agencies.

1.2 **System Water Audits, Leak Detection, and Repair:** Conduct annual prescreening audits, when necessary system audits, and alert customers to apparent leaks on their side of the meter.

1.3 **Metering with Commodity Rates for All New Connections and Retrofit of Existing Connections:** Require meters for all new service connections. Establish a program for retrofitting existing unmetered service connections. Read meters and bill customers by volume of use.

1.4 **Retail Conservation Pricing:** Conservation pricing provides economic incentives (a price signal) to customers to use water efficiently.

Education Programs:

2.1 **Public Information Programs:** Use public information programs as an effective tool to inform customers about the need for water conservation and ways they can conserve, and to influence customer behavior to conserve.

2.2 **School Education Programs:** Implement a school education program to promote water conservation and water conservation-related benefits.

Programmatic BMPS:

3. **Residential:** Implement the best and most proven water conservation methods and measures.

   Residential assistance program: Provide site-specific leak detection, conservation survey, and suggestions.

   Landscape water survey: Check irrigation system and timers, estimate landscape area, and develop irrigation schedule.

   High-efficiency clothes washers: Provide incentives or institute ordinances.

   WaterSense Specification (WSS) toilets: Provide incentives or ordinances requiring replacement of inefficient toilets.

4. **Commercial, Industrial, and Institutional:** Implement comprehensive yet flexible best management practices allowing each water agency to tailor the implementation of each practice to fit local needs and opportunities.

5. **Landscape:** Assist irrigators to achieve a higher level of water use efficiency consistent with the actual irrigation needs of plant materials.

The original MOU established the California Urban Water Conservation Council, comprised of one representative of each of the signatories, to monitor implementation and carry on the process. Nearly 100 water agencies, local governments, and organizations have signed the MOU.

Water efficient landscaping and irrigation reduce water use.
Photo: Amador Water Agency.

How do the Best Management Practices Relate to the General Plan and the Energy Aware Planning Guide?

Local governments can play a key role in implementation of the BMPs, which are consistent with the goals and objectives of this planning guide; namely to have clean, efficient, and healthy communities that require fewer resources. They are a starting point for local governments to integrate water conservation policies into their general plans. For example, general plan policies and ordinances can be adopted that require retrofitting for ultra low flush toilets when buildings are sold.

The water-related strategies included in the Guide are just a sampling of what local governments can do to conserve water. Other sources of information are listed in the introduction to the water policy section of the Guide.

For more information about the BMPs, contact the California Urban Water Conservation Council, c/o California Urban Water Agencies, 455 Capitol Mall #703, Sacramento, CA 95814, (916) 552-5885, http://www.urbanwater.com.

Endnotes

1. The MOU is available at http://www.cuwcc.org/mou-main-page.aspx .

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INTEGRATED REGIONAL WATER MANAGEMENT PLANNING

Water agencies, private water suppliers, and local governments share the burden of ensuring the delivery and reliability of local water supplies, though land use planning and water planning are not always coordinated. More often than not, county and city planning departments do not engage water agencies until the environmental review portion of the land planning process, and many times only then to comply with state legislation requiring verification of water supplies for certain development projects and not adequately representing water supply issues.

This can have detrimental effects on water use and land use patterns, and may pose conflicts between the efforts of water and land use agencies. For example, it is more difficult for a water agency to plan for future needs or upgrades without an accurate assessment of the amount, type, and location of future development. And it is difficult for land use agencies to plan for future growth without a clear sense of current and future water and infrastructure capacity.

Proposition 50 amended the California Water Code to authorize Integrated Regional Water Management (IRWM) projects to encourage regional management and to provide funding, via competitive grants, for projects to protect communities from drought, protect and improve water quality, and improve local water reliability and redundancy by reducing dependence on imported water.

Show me the Water Laws

In 2001, California passed related laws designed to improve coordination between water and land use agencies and ensure that water supplies are considered during local development decisions.

SB 221 (Government Code Section 66473.7) requires a city or county to provide written verification of sufficient water supplies by the water agency for proposed development projects above certain size thresholds (500 units or more for residential projects). Complying with SB 221 is the responsibility of the city or county that is approving the proposed project; the water agency need only document the availability of water for the new project. SB 610 (Water Code Section 10910-10915) requires a water supply assessment to be included in the Environmental Impact Report for projects large enough to trigger the law and thus provides the administrative process for implementing SB 221.

For the most part, this regional planning effort is meant to ensure coordination across jurisdictional lines, to gain economies of scale, and to produce watershed-wide benefits that may be lost through location-by-location planning. This integrated planning effort can also be between water and land use planning agencies, and the Ahwahnee Water Principles for Resource-efficient Land Use[1] were developed to help with this effort.

Regulatory programs, such as the "show me the water" laws, SB 375's regional planning requirements, AB 1881 landscape water use efficiency, and the expansion of the U.S. EPA's National Pollutant Discharge Elimination System's (NPDES) municipal separate storm sewer systems (MS4) rules to communities of 10,000 people, are also pushing more coordination at the local level to link issues like water, transportation, and public health to local land use decisions.

Strategies that increase water supply to satisfy the "show me the water" laws are not limited simply to importing more or developing new water, but can also include water conservation, reuse, and recycling. These alternative strategies also tend to require less energy. Further discussion of each can be found in strategies W.2.1, W.2.2, and W.3.1.

The NPDES permit requirements for most of California's cities and counties helps communities to focus on the land use-stormwater pollution connection. Stormwater rushing off lawns, buildings, driveways, parking lots, and streets carries pollutants, such as oils or fertilizers. The less stormwater that goes into a municipal storm sewer system, the less water that needs to be treated and thus the less the energy is needed. Policies to reduce and control stormwater volumes and pollutants can be found in strategy W.1.1.

The Clean Water Act and the National Pollutant Discharge Elimination System Program

Initially the National Pollutant Discharge Elimination System (NPDES) program was geared toward addressing pollution from factories and other "point sources" of pollution. In 1987, the NPDES program expanded to address discharges from stormwater systems.

This change brought cities and counties, as operators of municipal separate storm sewer systems (MS4s), under the regulatory provisions of the NPDES Municipal Stormwater Program.

The NPDES program was instated in two phases. Phase I regulations were directed at areas with a population of 100,000 or more. Phase II regulations were issued in 1999 to expand permit coverage to smaller communities with a population of less than 100,000, but generally over 10,000 residents.

To comply with the General Permit, Phase II communities are required to develop a Stormwater Management Program that implements appropriate best management practices (BMPs) to reduce the discharge of pollutants to the maximum extent practicable. Small MS4s permits now prescribe a set of six minimum control measures that must be implemented along with evaluation and assessment efforts:

1. **Public education and outreach;**
2. **Public participation;**
3. **Illicit discharge detection and elimination;**
4. **Construction site runoff;**
5. **Postconstruction runoff control; and**
6. **Pollution prevention and good housekeeping.**

Measure 5 is particularly relevant to the connection between water and land use planning. Postconstruction runoff control refers to management measures that address stormwater in areas once they are developed. This includes a growing array of planning and design strategies intended to reduce the impacts of development and impervious cover on water quality.

Swales reduce the amount of runoff entering surface waters.
Photo: Delaware Department of Transportation.

Endnotes

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WATER AND COMMUNITY DESIGN

The location and form of development affects water quality, demand and reliability, infrastructure costs and needs, and the health of the watershed as a whole, all of which have energy implications. Town-centered development with a greater mix of land uses and housing types, connected by safe and walkable streets, can reduce the impact of community development.

This makes community design an essential, but often-overlooked component of watershed planning and water management.

Lack of coordination between water and land planning can lead to development in areas that lack water or infrastructure to meet projected needs, excessive use of water, unpredictable approval processes, and less efficient capital expenditure.

Land planners are often only peripherally involved in deciding where water will come from, but have a significant impact on how much water is ultimately required. As a result, water and wastewater systems are built that may not conform to future development needs and vice-versa. If there is inadequate capacity to serve growth within a water or wastewater agency's service area or demands and discharges are not well managed, new growth may unnecessarily stress existing systems or be pushed into more remote areas, thereby encouraging low-density development patterns that threaten watershed health, water quality, and water reliability.

Mixed use infill projects reduce the impact of development.
Photo: Local Government Commission.

Similarly, the amount of growth expected is often not well coordinated with the amount of water needed, so an accurate and accountable water and wastewater budget is often not developed.

Dispersed development spread out across a wider area requires more extensive conveyance infrastructure to serve a given number of homes and businesses. This means higher costs for water service and more water lost through leakage. A system can lose from 6-25 percent of its water to leaks and breaks.[1] How much water is lost depends on the condition of the system, how far it has to carry water, and how much pressure is needed to deliver the water. More pressure means more leakage, and the farther a system has to carry water, the more pressure it will need.

Large lot single family-homes are characteristic of typical low-density development outside of town centers and require more land and water than more compact neighborhoods. Residential landscaping accounts for around 50 percent of household water demand, and larger lots tend to have more lawns and landscaping than smaller lots. Studies in Utah found that water use was cut in half, from 220 to 110 gallons per day, when density increased from two to five units per acre.[2]

Low impact development (LID) strategies, such as drainage swales and rain gardens, try to mimic natural hydrology before development. They retain and treat more stormwater on site to reduce flooding and the amounts of pollutants entering storm sewers and surface water bodies. LID can be implemented in very urban, suburban and rural locations.

Dispersed development requires more infrastructure and more energy to deliver water. Photo: Nonpoint Education for Municipal Officials (NEMO).

Endnotes

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STORMWATER REDUCTION

The National Pollutant Discharge Elimination System (NPDES) permit requirement for most of California's cities and counties encourages communities to focus on the land use-stormwater connection. The less stormwater that goes into a municipal storm sewer system, the less energy is needed for pumping and treatment. Cleaner stormwater carrying less fertilizer, oils, and other pollutants requires less municipal energy for treatment.

Development Impacts

Development adversely affects watersheds and the services they provide such as pollutant filtration and groundwater recharge. Development that occurs in ecologically valuable areas has a greater impact than in areas that are already disturbed or are less sensitive.

Development that is more spread out has a larger affect on watersheds because more area is fragmented with new roads, buildings, and infrastructure systems.

On a per capita basis, compact development patterns reduce the overall development footprint, minimizing land disturbance and impervious cover in the watershed. In addition, more land is left undeveloped or reserved for lower impact uses.

First develop compactly and in areas that are the least ecologically sensitive (see the land use and transportation section of this guide for ideas). Next, look at ways to

Rain gardens are a low impact development strategy.
Photo: US Department of Agriculture, Natural Resources Conservation Services.

reduce the impact of development sites such as on-site stormwater retention, green streets, and permeable pavement.

Low Impact Development

The term "low impact development" (LID) describes a set of stormwater management systems that minimize the water quality impacts of development. LID approaches try to mimic the natural hydrologic system as much as possible, using vegetation to slow down and treat stormwater, and soils to absorb and percolate stormwater.

LID approaches can be applied at multiple scales from a constructed wetland that seeks to treat runoff from an entire community to a small rain garden designed to capture runoff from a single rooftop. A set of design strategies can be linked together to create a "treatment train" of LID practices from the point where rain falls to the point of discharge into the creek, stream, or lake.

Regardless of where development occurs, low impact development (LID) techniques can reduce the amount of stormwater entering a municipal separate storm sewer system (MS4) and thus the amount of energy needed to pump and treat polluted runoff.

New National Pollutant Discharge Elimination System (NPDES) requirements apply to small MS4 communities (10,000 or more residents). LID may help satisfy permit requirements.

It is far easier and less costly to plan LID features and design concepts into the initial plan for a new development, than to try to retrofit later.

Green Streets

A street that uses vegetated facilities, such as swales, bioretention, and rain gardens to manage stormwater runoff at its source is referred to as a green street. A green street is a sustainable stormwater strategy that meets regulatory compliance and provides a more comfortable and aesthetically rich environment for all users.

Drainage swales collect stormwater runoff and may eliminate the need for storm sewers.
Photo: Local Government Commission.

Planting areas between the curb and sidewalk, as well as street medians, can be designed to manage stormwater by allowing water to be captured, retained, and filtered on site. These areas serve double duty by also providing an opportunity to increase groundwater recharge and tree canopy. Narrow, tree-lined streets also slow traffic speeds, enhance pedestrian comfort, and provide more area for open space or additional development on the same amount of land (see strategy L.4.3 Pedestrian Facilities and Traffic Calming).

In addition, well-shaded streets require resurfacing less often since they are less prone to deterioration from the sun[1] (see strategies L.3.1 Complete Streets and Street Design, and L.3.2 Street Trees).

Green Roofs

A green roof is a roof of a building that is partially or completely covered with vegetation and soil or other growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems. Green roofs capture rainfall, can provide an on-site source of irrigation water, and reduce the amount of water entering storm sewers.

The green roof on Chicago's City Hall.
Photo: Michigan State University.

Pervious Pavement

Pervious pavement is any constructed surface that allows water to percolate into the ground. Most paved surfaces are impervious, allowing no water infiltration and causing all the water falling on them to run off to either storm sewers or other surfaces.

Pervious pavements are "infiltration friendly" alternatives for low-traffic applications like parking stalls, driveways, pathways, and emergency vehicle access. Pervious pavements are made from normal building materials and installed with normal building equipment, making them readily available and easy to install. Examples include:

- Porous concrete;
- Porous asphalt;
- Unit pavers, bricks, and cobble installed with permeable joints;
- Reinforced grass, or turf block; and
- Crushed aggregate, or gravel.

Pervious pavement reduces runoff.
Photo: Illinois Environmental Protection Agency

General Plan Language Ideas

- The City/County shall adopt design standards that use low-impact development techniques that emulate the natural hydrologic regime and reduce the amount of runoff and associated pollutants. Examples include vegetated swales (landscaped depressions that capture and retain water to slow runoff, filter pollutants, and increase infiltration), landscaped detention basins, permeable paving, green streets, and green roofs.
- The City/County shall design new stormwater facilities to enhance recreational, habitat, and/or aesthetic benefits, as well as to integrate with existing parks and open space features.
- The City/County shall minimize pollution of stormwater, receiving water bodies and groundwater, and maximize groundwater recharge potential by:
    - Implementing planning and engineering design standards that use low-impact development techniques and approaches to maintain and mimic the natural hydrologic regime;
    - Utilizing "infiltration" style low-impact development technologies; and
    - Following stormwater Best Management Practices during and after construction.

Implementation Ideas

- **Adopt a Low Impact Development ordinance for all new development.** Demonstrate rain gardens, green roofs and stormwater-friendly parking lots at municipal facilities.
- **Require new open space/park facilities to serve multiple purposes,** including stormwater/flood control during the rainy season.

» **Develop materials for developers (guidelines, check lists) to help them implement green infrastructure.** Be sure that zoning ordinances or other local policies do not conflict with these materials.

» **Investigate the use of LID, green streets, and green roofs as a best management practice (BMP) for the MS4 permit.** Work with your regional water quality control district to quantify the stormwater reduction benefits of LID strategies, and then adopt them as BMPs in the stormwater permit.

Energy Savings

LID, green streets, green roofs, and permeable pavement reduce the volume of water entering MS4s and thus save the energy needed to pump and clean that avoided volume. They also may provide an on-site source of water for landscape irrigation.

California Academy of Sciences' green roof.
Photo: California Academy of Sciences.

Green roofs provide a layer of insulation, which can reduce the heating and cooling energy needs of the building. The green roof on Chicago's City Hall is estimated to save 9,272 kWh per year and 7,372 therms of natural gas for heating per year (see case study below).

Environmental Benefits

Low impact development techniques, including green streets, green roofs, and permeable pavement filter pollutants, increase infiltration, and reduce the volume of water entering storm sewers and surface waters (wetlands, streams, lakes, and coastal waters). They also reduce the volume and speed of stormwater entering rivers and streams, and the amount of erosion to their banks.

LID also increases groundwater aquifer recharge by allowing rain and irrigation water to remain on site long enough to percolate through soils as opposed to being quickly funneled to rivers and streams. In this way, LID supports trees and other natural vegetation on open space.

Green roofs reduce urban heat island effect, and can retain 60-100 percent of stormwater they receive.[2]

A 2002 U.S. Environmental Protection Agency study examined the stormwater impacts of new development at densities of one, four, and eight residential units per acre. The study illustrated that lower-density development patterns generate more impervious cover and runoff per unit than higher-density development for the same number of units.[3]

Denser development means less runoff per acre and per unit.
Graphic: U.S. EPA.

The EPA study corroborates other research on the effects of density on water, land conversion, and patterns of growth. At Purdue University, researchers examined two potential project sites in the Chicago area – one within an already developed area of the city and the other on the urban fringe. The study revealed that placing low-density development on the urban fringe would produce 10 times more runoff than a higher-density development in the already developed area.[4]

Economics

A developer in the Sierra Nevada found that costs decreased as more LID techniques were implemented in a project.[5] The LID design conformed to the natural topography, eliminating the need for mass grading and underground storm drainage, which are extremely expensive to build. The conventional "curb and gutter" design was replaced with bioswales, rock-lined culverts, crushed granite walking trails alongside each road within the subdivision, and utilization of existing natural flora.

Many of the design elements incorporated were also financially sustainable, in that they will ultimately cost the county and homeowners less money to maintain. Eliminating the standard "curb and gutter" design will reduce maintenance costs over the lifetime of the subdivision. In addition, the LID design also combats the effects of global warming by preserving trees that sequester carbon and by decreasing impervious surfaces, which will keep ambient temperatures cooler.

Beyond being cost effective, the developer found that using LID techniques and preserving natural infrastructure is highly marketable.[6]

When Village Homes in Davis was developed in the 1970s, bioswales cost $800 less per lot than underground storm sewers. The savings was used to plant landscaping capable of handling a 100-year storm which occurred in the first five years of the development. Other streets in Davis flooded with that storm, but Village Homes did not.

A green roof generates direct energy savings through a combination of shading, evapotranspiration effects, and insulation. Green roofs have a longer life span than standard roofs because they are protected from ultraviolet radiation and the extreme fluctuations in temperature that cause roof membranes to deteriorate.

The cost of Portland, Oregon's first green street project was $20,000. It consists of vegetated curb extensions large enough to store the initial peak flow of a 25-year storm without infiltration. That translates into a minimum 60 percent reduction in peak flow to storm sewers, and would provide protection for a majority of local basements regardless of the infiltration rate. Similar projects throughout the city combine to reduce the total volume of stormwater, allowing the city to manage stormwater with a smaller, less costly system.[7]

According to the Great Lakes WATER Institute, although the initial costs of installing a green roof are greater than a conventional roof system, the long-term benefits and the energy savings outweigh the original investment (e.g., increased longevity of the roof and savings on energy expenditures). The costs of a green roof will depend upon the design of the green roof such as the type (extensive or intensive), climate, and plant selection. Costs in 2004 were between $8 to $25 per square foot.[8] As water and electricity become increasingly scarce and expensive, the economics of green roofs and all LID options are likely to improve.

Programs in Operation

Portland, Oregon is a leader in using strategies that manage stormwater runoff, enhance community and neighborhood livability, and strengthen the local economy. In 2007, the Portland City Council approved a Green Street policy to promote and incorporate the use of green street facilities in public and private development.

The council recognizes that a comprehensive Green Street approach is an important development strategy to:

» Reduce polluted stormwater entering Portland's rivers and streams;

» Divert stormwater from the sewer system and reduce basement flooding, sewer backups, and combined sewer overflows to the Willamette River;

» Reduce impervious surface so stormwater can infiltrate to recharge groundwater and surface water;

» Increase urban green space;

» Improve air quality and reduce air temperatures;

» Reduce demand on the city's sewer collection system and the cost of constructing expensive pipe systems; and

» Address requirements of federal and state regulations to protect public health and restore and protect watershed health.

Communities in **Napa County** needed relief from periodic flooding. Instead of relying on conventional infrastructure to hold back floodwaters, the community partnered with the U.S. Army Corps of Engineers to design what they call "the Living River" approach. This approach relies on green infrastructure as a flood management strategy by reconnecting the river with adjacent floodplains, creating wetlands throughout the area, enhancing riparian habitat, and allowing for natural river dynamics to occur.

Goals of this project are to recreate the natural processes of the river by:

» Retaining the natural slope, width, and depth of the river;

» Maintaining and/or restoring the connection of the river to its flood plain;

» Allowing the river to meander as much as possible;

» Maintaining channel features such as mudflats, shallows, sandbars, and a naturally uneven bottom; and

» Maintaining a continuous fish and riparian corridor along the river.

As part of this project, over 300 parcels of land will be purchased along a 6.9-mile stretch of the river. Buildings, utilities, and train tracks within the floodplain will be demolished or relocated. http://www.co.napa.ca.us/Gov/Departments/DeptDefault.asp?DID=6.

In **San Francisco,** the California Academy of Sciences has probably the most visible example of a green roof in California. The Academy's new living roof is planted with nine native California species that will not require artificial irrigation. The planted area measures 2.5 acres, which is now the largest concentration of native vegetation in San Francisco. Approximately 1.7 million plants blanket the living roof. The native plants will provide habitat for a wide variety of wildlife. By absorbing rainwater, the new Academy's living roof will prevent up to 3.6 million gallons of runoff from carrying pollutants into the ecosystem each year (about 98 percent of all storm water). The new building gained LEED Platinum certification in 2008. http://www.calacademy.org/newsroom/releases/2008/leed_platinum.php.

A rooftop garden sits atop **Chicago's** City Hall. First planted in 2000, the rooftop garden was conceived as a demonstration project – part of the city's Urban Heat Island Initiative – to test the benefits of green roofs and how they affect temperature and air quality. The plants were selected for their ability to thrive in the conditions on the roof, which is exposed to the sun and can be windy and arid. Most are prairie plants native to the Chicago region.

The rooftop garden improves air quality, conserves energy, reduces stormwater runoff, and helps lessen the urban heat island effect by replacing what was a black tar roof with green plants. The garden absorbs less heat from the sun than the tar roof, keeping City Hall cooler in summer and requiring less energy for air conditioning. The garden also absorbs and uses rain water. It can retain 75 percent of a one-inch rainfall before stormwater runoff enters the sewers. The garden is projected to save $3,600 in avoided energy costs, including 9,272 kWh of electricity and 7,372 therms of natural gas per year. http://egov.cityofchicago.org/city/webportal/portalEntityHomeAction.do?entityName=Environment&entityNameEnumValue=05.

Resources

The California State Water Resources Control Board has multiple programs and funding to assist communities in the state. The Board's mission is to preserve, enhance, and restore the quality of California's water resources, and ensure their proper allocation and efficient use for the benefit of present and future generations. The Board's web site includes information on NPDES compliance and LID and stormwater management techniques.http://www.swrcb.ca.gov.

The Low Impact Development Center is a nonprofit organization dedicated to the advancement of Low Impact Development technology. Low Impact Development is a new, comprehensive land planning and engineering design approach with a goal of maintaining and enhancing the predevelopment hydrologic regime of urban and developing watersheds. The web site has a host of LID materials and links to other programs. http://www.lowimpactdevelopment.org.

The Low Impact Development (LID) Urban Design Tools web site provides watershed managers with a set of tools and techniques that can be used to meet regulatory and receiving water protection program goals for urban retrofits, re-development projects, and new development sites.

This site has been developed through a Cooperative Assistance Agreement with the U.S. EPA Office of Water in order to provide guidance to local governments, planners, and engineers for developing, administering, and incorporating Low Impact Development (LID) into their aquatic resource protection programs. http://www.lid-stormwater.net.

The California Water and Land Use Partnership (CA WaLUP) is an informal partnership among state and federal agencies and nonprofits that have a strong interest in improving water quality in the State of California. The mission of CA WaLUP is to improve water quality and supply and conserve natural resources through the protection of watershed integrity by providing technical information and practical tools to support informed land use decision-making at the local level. The program addresses land use issues and promotes the use of integrated land use planning, community design, and site design strategies that serve to prevent or reduce the impacts of development on water resources.

CA WaLUP is a member of the National NEMO Network. NEMO is an educational program for land use decision-makers addressing the relationship between land use and water resource protection. http://www.coastal.ca.gov/nps/lid-factsheet.pdf.

The U.S. EPA's LID Web Page provides fact sheets, design manuals, and links to information resources on Low Impact Development. http://www.epa.gov/nps/lid.

Green Roofs for Healthy Cities is a small network of public and private organizations founded as a direct result of a research project on the benefits of green roofs and barriers to industry development. Its mission is to increase the awareness of the economic, social, and environmental benefits of green roof infrastructure across North America and rapidly advance the development of the market for green roof products and services. http://www.greenroofs.org.

Related Strategies

W.2.1 Water Efficient Landscaping

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WATER EFFICIENT LANDSCAPING

On average, about one half the water consumed in residential development goes to landscape irrigation. Waterwise landscaping makes use of plants, soils, planting materials, irrigation technologies, and other practices to increase water efficiency while providing a healthy and beautiful landscape.

Drought tolerant and native plants that are accustomed to local conditions are lawn alternatives that tend to require fewer or no pesticides and fertilizers (significant contributors to water contamination), and require little or no irrigation or mowing. In addition to saving water, water-efficient landscapes can reduce the amount of energy used to pump and treat water, and the amount of yard waste.

Irrigation systems play a significant role in how much water is used for outdoor watering. New automatic irrigation technologies use sensors that can evaluate soil moisture, temperature, weather, and even evapotranspiration rates, and then irrigate based on how much water plants actually need. Smart irrigation technology may solve the water quantity and quality problems of overwatering, and make landscape maintenance easier for residents.

AB 1881 charged the California Energy Commission to adopt standards and labeling requirements for landscape irrigation equipment to reduce the unnecessary consumption of excess energy or water.[1] The legislation also required the Department of Water Resources to update the Model Water Efficient Landscape Ordinance and local agencies to adopt this ordinance or one more stringent by 2012.

Drought tolerant landscaping requires less water for irrigation.
Photo: Riverside Utilities.

Water for landscaping is one preferred use of recycled water. See strategy W.3.1 Water Reuse and Recycling for more details.

General Plan Language Ideas

» The City/County shall adopt a Water Efficient Landscape Ordinance, as required by state law. The ordinance shall be at least as stringent as the model ordinance adopted by the California Department of Water Resources. The ordinance shall require new and rehabilitated landscaping to be water-efficient and include requirements and technical assistance programs to improve the water efficiency and reduce overall water demand of existing landscapes.

» The City/County shall work with the local water agency to develop an education and incentive program for businesses and residents retrofitting existing landscapes with water efficient and conserving landscapes. California's Water Code Section 375 allows any public entity that supplies water to adopt and enforce a water conservation program. Simple upgrades such as retrofitting existing development with more efficient appliances and plumbing at the time of sale can be required. Local governments can work with water suppliers to provide incentives, system audits, rebates, and outreach programs to help residents, property managers, and developers incorporate efficiency measures.

» All new City/County landscaping shall be designed to minimize water use (in accordance with the ordinance) and maximize energy efficiency.

» The Parks and Public Works Departments shall develop and implement a program by [date] to retrofit existing landscaping on municipal property to minimize water use and maximize energy efficiency.

Implementation Ideas

» **Adopt a water efficient landscape ordinance.** Approved by the State Legislature in 1990, the Water Conservation in Landscaping Act requires local governments to adopt a water efficient landscape ordinance, unless the city/county can demonstrate it is unnecessary. The California Department of Water Resources (DWR) has developed and regularly updates a model ordinance. If a city or county fails to adopt its own ordinance or make a finding that they do not need such an ordinance, the model ordinance will take effect. A local ordinance could also integrate requirements for energy-efficient landscaping (see strategy B.1.7 Shade Trees) and fire-retardant landscaping.

» The model ordinance adopted by DWR applies to all new and rehabilitated landscaping for public agency projects and private development projects requiring a permit and developer-installed landscaping in residential developments. Landscaping under 2,500 sq. ft. is exempted. Requirements include several prescriptive measures, such as automatic controls on irrigation equipment and grouping plants with similar water needs. In addition, the landscape must be designed to use no more water than a "maximum applied water allowance" calculated based upon the project location in the state. The model ordinance also provides that existing landscaped areas of one acre or more must have an irrigation efficiency audit at least every five years (see the Resources section below for a link to the model ordinance).

» **Enforce the landscape ordinance.** Without strong enforcement, the benefits of the water efficient landscape ordinance will be lost. Plan reviewers and building inspectors should receive training and must be knowledgeable about low water landscaping. Offer education programs for developers, landscape architects, and landscape installation firms. Assign or hire a staff person to coordinate all low-water landscaping activities, including ordinance implementation and education and incentive programs.

» **Offer incentives and educate existing residents and businesses.** Built-out communities in particular should concentrate on encouraging residents and businesses not to over-water and to retrofit existing landscapes. Working with the local water agency, cities and counties can offer a wide range of incentives and education programs.

» **Install efficient landscapes at city/county facilities.** Design all new landscaping around buildings, along streets, in traffic medians, parks, and other public places to minimize water consumption. For example, lawns are inappropriate for narrow spaces in traffic medians and along streets, use a low-water ground cover instead. In addition to serving as a model for residents and businesses, landscapes using native vegetation can reinforce the character and heritage of the community.

» **Retrofit existing local government landscapes.** Audit parks and other landscaped areas to determine how to water more efficiently and how landscapes can be retrofitted with more efficient irrigation equipment and drought-tolerant vegetation. Next, develop a plan and schedule to retrofit landscapes. For example, medians can be relandscaped when other work is performed on the street or in conjunction with new development. Include retrofit projects in the capital improvement budget.

» **Develop landscaping guidelines for your community.** Local governments can work with local water agencies to develop a list of locally appropriate plants and gardening landscaping practices to reduce the need for excess watering and to reduce the amount of green waste going to landfills.

» **Prohibit homeowners associations from requiring front lawns.**

Energy Savings

The energy used for pumping water will depend upon the source (e.g., surface or groundwater) and the distance. For example, pumping an acre-foot of water (325,900 gallons) through the State Water Project system uses about 1,750 kWh of electricity.[2]

Saving water saves energy. A study in Nevada found that changing from turf to xeriscaped yards (landscapes that do not need supplemental water) resulted in a 33 percent reduction in water use.[3]

Environmental Benefits

Saving water helps to maintain fisheries, wetlands, and other sensitive ecosystems.

Using native plant species and efficient irrigation can reduce landscape trimmings and weeds that may otherwise be trucked to a landfill. The use of highly polluting mowing equipment is also reduced. Lowering water use will reduce air emissions from power plants used to produce electricity needed to pump and treat water.

Landscapes using native plants or other plants appropriate for the site often require fewer pesticides, herbicides, and fertilizers, reducing the use and disposal of potentially hazardous substances that can pollute groundwater, pose risks to humans and ecosystems, and require major amounts of energy to manufacture.

Irrigation systems play a significant role in how much water is used for outdoor watering. Irrigation practices affect water quality; runoff from over-watered lawns can carry high concentrations of chemical treatments, such as fertilizers and pesticides, into local waterways.

Overspraying and overwatering wastes water.
Photo: University of Florida.

Economics

Xeriscapes may cost slightly more to design and install; however, cost savings from reduced maintenance and water will offset these initial costs.

When developing the model water efficient landscape ordinance for 2009, the California Department of Water Resources estimated that the cost of installing a water efficient landscape would not exceed the cost of installing landscapes not subject to the ordinance, or would be only minimally higher. The DWR also found that completed projects would result in overall lower water costs.[4]

Converting to xeriscape saves money. The following are costs for projects in Arizona, based on 2002 estimates that vary depending on site requirements:

» Cost to convert from turf to xeriscape: 50 cents to $2.04 per square foot.

» Estimated payback period: 2.5 years to 6 years.

» Water savings: Costs cut by one half to two-thirds.[5]

These projects saved not only on water costs, but also on maintenance. Maintenance costs for various landscape types were:

» Lush, traditional landscape with lots of turf and water-loving plants: $1,300 to $2,600 per acre per month.

» A heavily planted and “over-maintained” desert landscape: $900 to $1,700 per acre per month.

» A moderately maintained desert landscape with selective pruning: $500 to $900 per acre per month.

» A very natural landscape, where minimal pruning is necessary: $175 to $300 per acre per month.[6]

Programs in Operation

The **Coachella Valley Water District** has adopted the Landscape and Irrigation System Design Criteria ordinance whose purpose is to conserve water by establishing effective water efficient landscape requirements for newly installed and rehabilitated landscapes.

It is the intent of the district to promote water conservation through climate appropriate plant material, efficient irrigation systems, and to create a “lush and efficient” landscape theme through enhancing and improving the physical and natural environment. Contact: Coachella Valley Water District, http://www.cvwd.org/conservation/conservation.php.

The **Sonoma County Water Agency,** through its Water Conservation Department, develops and implements an array of water conservation programs and rebates. Through the Qualified Water Efficient Landscaper (QWEL) Program, local landscape professionals are making a positive impact towards reducing landscape water demand by becoming more water efficient in landscape design, maintenance, and operation. QWEL provides an educational foundation based on principals of proper plant selection for the local climate, irrigation system design and maintenance, and irrigation system programming and operation. Registration for the QWEL Program is free. Contact: Sonoma County Water Agency, www.scwa.ca.gov/water_conservation.

The city of **Santa Cruz** has a Landscape Water Conservation Ordinance whose purpose is to lower the demand for water, particularly during the months of April through October when water needs are highest, and to preserve water in storage for emergency use during drought years. All persons applying to the Santa Cruz Water Department for new or increased water service must meet the specific water conservation standards in their landscape design. Existing customers that are required to relandscape their property as part of a land use approval process must also comply with the city’s water conservation standards in the relandscape area.

Residential properties with one or two living units on less than one half acre are required only to limit turf grass to no more than 25 percent of the landscape area, and lawns may not be used in areas less than eight feet wide; turf grass must be a water-conserving species, such as tall or hard fescue; and high water use plants may be planted in no more than 10 percent of the nonturf landscape area. The remaining landscape must be planted with low and moderate water use plant materials. Plants having similar water requirements should be grouped together in distinct hydrozones. Contact: City of Santa Cruz Water Department, http://www.ci.santa-cruz.ca.us/wt.

As part of its **Sustainable Santa Monica** program, the city is working to reduce citywide water consumption by 20 percent from 2000 to 2010. Sustainable water consumption means using water no more quickly than the rate at which it is restored. Santa Monica could be a completely sustainable city if it were able to supply all of its water needs from local well sources indefinitely. Reducing water consumption per capita and increasing the percentage of water that comes from local sources are two important steps toward sustainability. The city offers landscape grants for native landscaping projects. It supports residential water efficiency programs including the “20 Gallon Challenge,” which encourages individuals to save 20 gallons of water each day by implementing water saving strategies for both indoor and outdoor water use. Contact: Sustainable Santa Monica, http://www01.smgov.net/epd/scp.

The City of **San Diego** is committed to leading by example and to conserving water use within every department. City efficiency programs have resulted in water savings of 11.5 percent, primarily due to the efforts of the Parks and Recreation Department. These savings are better than the citywide average of 5.5 percent. The San Diego Water Department cohosts (with the Metropolitan Water District of Southern California) a series of free classes designed to help gardeners save water (and money) while making sure their gardens are as colorful, healthy, and attractive as ever, and has developed the City of San Diego Landscape Watering Calculator, an easy-to-use tool that helps estimate the right amount of water to give a landscape or garden. The calculator is designed to give a weekly schedule for the maximum amount of water which plants may need each month of the year. Because everyone's landscape is different, the calculator uses average numbers for weather, plants, and soils in San Diego. http://www.sandiego.gov/water/conservation.

The **South Tahoe Public Utility District's** "Turf Buy Back Program" provides a cash rebate to residential customers for reducing the amount of lawn area in their yards. The district has used two state funded water conservation grants to provide voluntary lawn buy-backs at $2 per square foot for customers who wish to replace their lawns with less water-intensive, landscaping options. The incentive for lawns larger than 1,500 square feet is $1.50 per square foot. Eligibility requirements include a minimum of 400 square feet of irrigated, maintained lawn (preconversion). The converted landscape must employ water-efficient irrigation systems and planting materials such as mulch, a 50 percent living plant cover at maturity, and selection of native and adapted plants. http://www.stpud.us/water_conservation.html.

Faced with the need to secure additional water supplies, **Tucson, Arizona's** Water Department instead decided to decrease demand by creating a highly visible "Beat the Peak" campaign. The campaign encourages residents to do outdoor watering at off-peak periods. The agency increased water rates across the board and created a new-tiered rate structure that increases the cost of water as consumption increases.

Started in 1977, the campaign has proven highly effective. According to a 2006 report by Western Resource Advocates, the average person in a single-family residence in Tucson uses 114 gallons of water per day, one of the lowest usage rates in the Southwest. Even by the 1980s, residents had noticeably changed their water habits to reflect the fact that they live in a desert environment. As an added bonus, outdoor conservation has led to indoor water conservation. http://www.ci.tucson.az.us/water/beatthepeak.htm.

Resources

The **California Department of Water Resources (DWR)** offers numerous resources for local governments. Grants and/or loans are available for water conservation, agricultural water recycling, groundwater management, water quality and supply, and studies and activities to enhance local water supply reliability. Project eligibility depends on the type of organization(s) applying and participating in the project and the specific type of study or project. More than one grant or loan may be appropriate for a proposed activity. http://www.grantsloans.water.ca.gov.

The **Office of Water Use Efficiency and Transfers** at DWR can offer technical assistance on urban and agricultural water conservation. The Office prepared the Model Water Efficient Landscape Ordinance. For a guide to plant selection and irrigation in consideration of water needs, see http://www.owue.water.ca.gov/landscape/faq/faq.cfm.

The **Metropolitan Water District** is a consortium of 26 cities and water districts that provides drinking water to nearly 18 million people in Southern California. MWD offers information on California friendly gardening, including guides, classes, model gardens, and rebate programs. http://www.mwdh2o.com.

Alameda County's StopWaste.org has developed Bay-Friendly Landscape Guides for residents, businesses, and local governments in the Bay Area. Model ordinances and general plan language area also available. StopWaste.org also provides workshops for residents and landscape professionals, and tours of model gardens. Contact: StopWaste.Org, http://www.stopwaste.org.

The **Sierra Nevada Alliance** developed a resource helping Sierra homeowners create a beautiful yard and garden that guards against wildfire, needs little maintenance, flourishes with native and adapted plants, exists in harmony with wildlife, and protects and conserves Sierra water. "Sierra Nevada Yard and Garden: A homeowner's guide to landscaping in the Sierra" is available at http://www.sierranevadaalliance.org/publications/SNLG.

Sacramento Stormwater Quality Partnership has developed principles for river-friendly landscaping that: landscape with local plants, send less green waste to landfills, nurture soils, conserve water and energy, protect air and water quality, and create and protect wildlife habitat. SSQP has developed landscape guidelines, help with choosing a landscape professional, and hosts workshops for residents and professionals. Visit http://www.sacramentostormwater.org/SSQP/riverfriendly/default.asp.

Related Strategies

W.2.2 Water Conservation Pricing
W.3.1 Water Reuse and Recycling
B.1.7 Shade Trees

Endnotes

1. California Department of Water Resources web site. Accessed July 2009. *Updated Model Water Efficient Landscape Ordinance AB 1881.* http://www.owue.water.ca.gov/landscape/ord/updatedOrd.cfm.
2. DWR. 2007. *Management of the State Water Project, Bulletin 132-06.* Sacramento: Department of Water Resources. http://www.water.ca.gov/swpao/docs/bulletin/06/Bulletin132-06.pdf.
3. Alliance for Water Efficiency web site. Accessed July 2009. http://www.a4we.org/Xeriscape_Water_Savings.aspx.
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WATER CONSERVATION PRICING

When the retail price of water does not reflect the true costs of developing, storing, treating, and providing that water service, consumers receive mixed signals that can create conflicts, frustration, as well as inefficiency. Rate structures can be designed to incentivize efficient water use and efficient land use patterns by accounting for the variation in cost of service that results from different development consumer behaviors and locations.

Customers typically pay for water in two ways – through use charges and through hookup or connection fees. Uniform use fees do not encourage conservation when water conservers and water wasters pay the same price. Customers that do conserve end up subsidizing those that do not.

Uniform, or "flat," connection fees do not recognize the influence that development location and density have on service costs. Users in compact, centrally located developments subsidize the costs of extending service to customers in suburban developments on the community fringe. When everyone pays the same rate, there is no incentive to locate in an area that is easier or less expensive to serve.

Conservation Pricing

Volume-based water rates provide better information to customers about their actual water use and tend to discourage excess water consumption. Properly set water rates that include all fixed and variable costs associated with water service more accurately reflect the value of water and the costs of planning for, securing, treating, and delivering it to customers. Uniform use rates charge the same amount regardless of the level of consumption, meaning that a customer using water-wise landscaping and efficient indoor appliances, and practicing conservation will be charged the same monthly fee as a customer who does none of those things and uses more water.

Block pricing applies variable rates depending on the amount of water used. Increasing tiered block rates charge higher rates as consumption increases. The lowest rate or base rate usually covers an initial volume of water deemed reasonable for basic household needs. The base rate increases with surcharges on additional blocks (for example, at 2,500 gallon increments) of water used.

Increasing block rates can be a highly effective way to encourage conservation while recouping the costs of providing service. Increasing block rate structures can also increase revenue for water agencies as they reflect costs more accurately – those who cost more to serve pay more for service.

Decreasing block rate prices reflect per-unit costs of production and delivery that go down as customers consume more water. The monthly water use records of 101 customers were measured in a study of municipal water use in Denton, Texas. Summer water use records from 1976 to 1980 during a decreasing block rate period were compared to summer use records from 1981 to 1985 during an increasing block rate period. It was found that the decreasing block rate scenario encouraged greater water use, whereas the increasing block rate scenario resulted in a reaction to the price increase and a corresponding decrease in water use.[1]

According to a study by Western Resource Advocates, a properly designed block rate structure:

» Provides water at low prices for basic and essential needs so all customers can afford it;

» Rewards conserving customers with lower unit rates for water;

» Encourages efficient use by sending a strong conservation price signal;

» Assigns water supply and development costs proportionately to the customers who place the highest burden on the supply system; and

» Does all of the above while still maintaining a stable flow of revenue to the utility.[2]

Zone Pricing

Spread out development increases water demand and raises energy costs (more power is needed to move water farther distances) and infrastructure costs (longer lines are needed for delivery). Zone pricing sets rates based on distance, pressure zones, or lot size. A zone structure can be relatively simple; it can be based on costs and lengths of distribution lines, pumps to maintain pressure, and energy needed for delivery so that more distant development pays more than development that is centrally located.

Zones can also reflect *General Plan* land use designations to account for cost variability related to density. Lower density areas cost more to serve and consume more water per capita than higher density areas. Thus, pricing can be linked to zoning districts.

Low-density development is more costly to serve.
Photo: Local Government Commission.

AB 2882, signed into law in 2008, encourages public water agencies throughout the state to adopt conservation rate structures that reward consumers who conserve water. Current state law authorizes water agencies to promote conservation using rate structures. However, some agencies are concerned that such structures may not meet the requirements of Proposition 218, a state law enacted by voters in 1996 to restrict the use of revenue tools such as water rates to finance unrelated local services. This legislation clarifies the allocation-based rate structures and establishes standards that protect consumers by ensuring a lower base rate for those who conserve water and requiring that higher rates for use in excess of the base rate do not exceed the reasonable cost of providing the water service.

Higher density, infill projects are less costly to serve.
Photo: Local Government Commission.

General Plan Language Ideas

» The City/County shall coordinate with the local water district to develop a list of feasible water conservation programs and incentives that might be offered to the district's customers, and develop related strategies for how the city/county might support the district's efforts in implementing these programs.

» The City/County shall commit to implement Best Management Practices (BMPs) of water conservation. Such measures include:

- Requiring meters for all new connections and billing by volume;
- Accelerating the installation of meters on unmetered connections and billing by volume;
- Identifying intra- and inter-agency disincentives or barriers to retrofitting mixed-use commercial accounts with dedicated landscape meters; and
- Conducting a feasibility study to switch mixed-use accounts to dedicated landscape meters.

» The City/County shall adopt a water conservation rate schedule that increases as the quantity of water used increases (i.e., a tiered rate schedule) and/or provides seasonal rates or excess-use surcharges to reduce peak demands during summer months.

» The City/County shall work with the water district to investigate whether substantial differences exist in the cost of providing water service to different areas of its jurisdiction in order to justify instituting zone pricing for water service. These costs can be related to both providing initial hook up and eventual water delivery.

Implementation Ideas

» Working with the local water district, **institute conservation pricing for water services that reflect actual fixed and variable costs,** and provide easy access to information and equipment to help the residents and businesses affected to reduce their consumption.

» **Use zone pricing to encourage new development within the existing footprint of the community** if there are substantial differences in the cost of providing water for infill versus greenfield development.

Energy Savings

Conserving water reduces the amount of energy needed for water pumping and treatment.

Pumping water for shorter distances requires less energy and materials. When new development is located nearer to existing development and water service infrastructure, less energy is needed to deliver the water to that development.

Environmental Benefits

Saving water helps to maintain fisheries, wetlands, and other sensitive ecosystems.

Economics

The cost of procuring and developing water resources will continue to rise as California's population increases. Conserving water is the cheapest source of new supply. Conserving water can also delay the need for new, larger infrastructure to deliver fresh water and to treat wastewater.

Charging the true fixed and variable cost of providing water services to distant development will either encourage closer in, easier, and cheaper to serve development (the preferred alternative), or at least will not force the cheaper-to-serve customers to subsidize their more-costly-to-serve neighbors.

Programs in Operation

Drought conditions in 2008 prompted the **East Bay Municipal Utility District** (EBMUD) to adopt new conservation rates to encourage customers to reduce water use. EBMUD increased volume charges by 10 percent and added a drought surcharge for high water use. The rate change is expected to reduce overall water use by 10 percent and generate $6 million in revenue.[3] The rate increase will help fund EBMUD's drought management program and offset revenue loss from reduced water sales. Customers who use less than 100 gallons a day will be exempt from the rate increase and surcharge. EBMUD provides free conservation devices, workshops, and water surveys to help customers reduce their use. Contact: East Bay Municipal Utility District, http://www.ebmud.com.

When rapid population growth led to dwindling supplies and increased wholesale water charges, the **Irvine Ranch Water District** implemented a new fee structure that rewards water efficiency and identifies waste when it occurs. The long-term goal was to develop a water-wise conservation ethic within the community while maintaining stable utility revenues. Within a year, water use declined by 19 percent. Over the next six years, the district saved an estimated $33 million in water purchases. For more information: Irvine Water District Conservation Office, http://www.irwd.com/Conservation.

Resources

The **California Department of Water Resources** (DWR) offers numerous resources for local governments. Funded by the Water Conservation Bond Law of 1988 (Proposition 82), DWR offers loans of up to $100,000 per feasibility study and up to $5 million per project to public agencies for water conservation. Contact: Department of Water Resources, Division of Local Assistance, Loans and Grants Program, P.O. Box 942836, Sacramento, CA 94236-0001, (916) 445-8259.

DWR publishes a water conservation tips and information. Visit http://www.owue.water.ca.gov/conservlinks/conservlinks.cfm.

Related Strategies

W.2.1 Water Efficient Landscaping
W.4.1 Efficient Wastewater Treatment

Endnotes

1. Nieswiadomy, M. and Molina, D. 1991. *A Note on Price Perception in Water Demand Models Land Economics 67(3).* http://www.jstor.org/pss/3146430.

2. Fort, D. 2006. *Water Rate Structures in New Mexico: How New Mexico Cities Compare Using This Important Water Use Efficiency Tool.* Boulder: Western Resource Advocates http://www.westernresourceadvocates.org/water/rates.php.

3. East Bay Municipal Utility District Board of Directors Meeting. January 27, 2009. http://ebmud.com/about_ebmud/board_of_directors/board_meetings/special_meeting_agenda/staff_reports/012709_drought_management_program_update_workshop_reports.pdf. .

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ENERGY AWARE PLANNING GUIDE

W.3.1

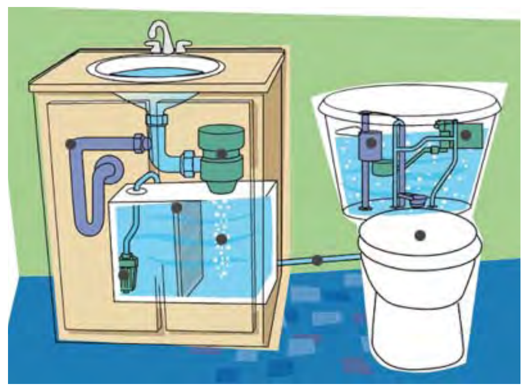
WATER REUSE AND RECYCLING

Water is commonly used just for one purpose and is then conveyed to a wastewater treatment plant, where it is treated and released back into the environment. Regardless of use – drinking, washing, irrigating, cooling – this water is treated to potable standards even though such high level of treatment isn't required for the end use. Water reuse, on the other hand, allows water to perform more tasks between its first use and when it is released back into the environment.

Communities can stretch their current water supplies by creating opportunities for water to perform double duty. For instance, instead of letting soapy water from a bathtub or shower go down the drain to be carried away to a treatment facility, it can be redirected and reused onsite in the garden or to irrigate outdoor landscaping. This type of arrangement is a part of a graywater system.

Graywater is untreated wastewater that has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. Graywater includes wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but not from kitchen sinks or dishwashers.

Graywater is more appropriate for reuse onsite for irrigation or other uses, while wastewater must first be highly treated by a central wastewater facility before it can be reused for other applications, such as irrigation (e.g., golf courses, landscaping, agriculture, etc.).



This AWUS® toilet system disinfects and redirects water used in the bathroom sink to be reused as water for toilet flushing.
Photo: Watersaver Technologies, LLC.

Water recycling is an umbrella term that encompasses the treatment, storage, distribution, and reuse of municipal and/or industrial wastewater. Recycled water, although highly treated, is considered nonpotable. A dual-plumbing system is used with the recycled water carried in purple-colored pipes to prevent the unintentional misuse of recycled water.

Recycled water has been used by California communities since 1929 with no reported health problems. State law indirectly requires the use of recycled water. California Water Code Section 13550-13556 states that if recycled water is available, then the use of potable domestic water for nonpotable uses, including cemeteries, golf courses,

Recycled water is carried in purple pipes to ensure it remains separate from potable water. Photo: Denver Water.

parks, industrial and residential irrigation uses, and toilet flushing, is an unreasonable use of water.

As an incentive for creating programs that encourage the reuse of water, the water saved can be counted as a source of water to meet the requirements of new state "show me the water" laws that require developers to prove that enough water is available to serve proposed new housing (see the Background section on Integrated Regional Management Planning). Both recycled and reused water are alternatives that can be used to satisfy landscape, industrial, or cooling water needs, which can reduce the demand for highly treated water. This saves more higher quality water to be used for domestic or potable uses where there are no alternatives.

Local governments and water agencies are the key players in the recycled water arena. Water agencies provide the commodity, and local governments provide the political will and regulatory framework. They need to work closely to ensure the inclusion of recycled water in each of their planning documents, and consider sharing resources for a joint public-private venture, which may include the development of necessary reclamation and treatment facilities.

General Plan Language Ideas

» The City/County shall investigate the feasibility of using graywater systems and consider phasing in requirements or incentives for the incorporation of graywater systems in new development.The policy should also provide for the use of rainwater capture systems for outdoor irrigation. Public health and building officials shall evaluate design considerations for winter conditions.

» The City/County shall require dual drains and/or purple pipes for recycled water to be installed in new construction.

Implementation Ideas

» **Develop a graywater ordinance** consistent with state plumbing code, which regulates permitted uses and system requirements. Permit requirements for graywater systems can be further divided based on project size and flow. For instance, a simple residential graywater system handling a flow of less than 400 gallons per day may be granted a permit without inspection or fees, but a larger multihome project may need technical and environmental review before a permit is awarded.

» **Amend city/county building codes to require the installation of dual-purpose pipes** (purple pipes) in new construction and remodels so that they are set up for safe use of recycled water supplies.

» **Work with developers to create incentives or otherwise streamline the deployment of dual-plumbing systems** and initiate public discussion through outreach and education. Creating forums to share the benefits of using recycled water and address public concerns and questions will help build public understanding and support a recycled water program.

» **Adopt a water recycling ordinance.** The California section of the WateReuse Association web site provides a model water recycling ordinance (www.watereuse.org/ca/modelwrord.htm). The ordinance's intent is to maximize resource conservation and streamline implementation of water recycling projects in conformance with state law. The ordinance can also be tailored to conform with local rules and regulations.

Recycled water used for irrigation.
Photo: South Sonoma County Resource Conservation District.

Energy Savings

Water that is reused in a graywater system eliminates the need to pump and treat an equivalent amount of new potable water for the site and augments existing local resources, eliminating the need to import additional supplies.

Water recycling uses energy to pump, treat, and rerelease the water into a purple pipe system. Depending on the use of the recycled water, the amount of treatment, and therefore the amount of energy consumed by this treatment, can be less than the amount needed to treat water to drinking quality water, to import additional supplies, or to develop new sources such as ocean desalination, which would otherwise be provided for that use. Common uses are for landscape watering (including golf courses), cooling, industrial processes, fountains, and toilets.

Environmental Benefits

Using graywater instead of drinking-quality water for on-site landscape irrigation can keep lawns and gardens green – even in times of drought – and alleviate water demand in areas prone to water shortages. Wastewater treatment facilities will also have less volume to treat, and can delay expansion of those facilities.

Graywater can be better for a garden than using treated drinking water. Soap and other products in wastewater are rich in compounds that can pollute waterways, wear out septic systems, and overburden wastewater facilities. However, these same materials – phosphorous, nitrogen, potassium, and proteins – are sources of nutrients for fruit trees, landscaping, and gardens.[1]

Treated or recycled water can be used to replenish groundwater supplies and be stored for future use.

Recycled water can be used to enhance or restore wetlands that provide wildlife habitat, flood protection, improved water quality, and recreational amenities. It can also reduce the volume of potable water that must be withdrawn from rivers, lakes, and groundwater, thus helping to maintain the natural ecology of those bodies of water.

Economics

Graywater makes sense in low-density environments that are served by septic systems and leach fields or in situations where treated wastewater is not available (or cost effective) on a municipal or institutional scale.

Graywater systems can be affordable to install if done at the time of construction. Individual customers can save money on their metered water bills when water is used more than once.

Reusing graywater for outdoor or nonpotable uses like landscaping can be a promising approach to limiting the demand for potable water and for demonstrating an adequate supply of water for a new development.

While the economics of recycled water depend upon place and use, it can be less expensive than purchasing new supplies. Matching water quality to end-use saves money for both the buyer and water agency. For example, the quality needed for landscaping is not as high as that needed for drinking water.

Similar to graywater systems, installing purple pipe during construction is much less expensive than retrofitting a facility. By requiring purple pipes in new construction where recycled water is not currently available, communities will be building the infrastructure for the future when recycled water is available.

Recycled water systems require regular preventative maintenance and inspection.

Programs in Operation

The **Marin Municipal Water District** was the first water supplier in California to use recycled water for car washes, air conditioning cooling towers, and commercial laundries. Since the early 1980s, the district has pioneered the use of recycled water for nonagricultural uses in Northern California. Up to two million gallons per day are recycled and distributed to more than 250 customers. The district also manages the demand for water by encouraging efficient water use through various conservation programs. http://www.marinwater.org.

The City of **Malibu** inserted graywater installation requirements in its General Plan: "New development shall include a separate graywater treatment system where feasible.[2]" The city has developed a graywater ordinance and handbook that helps residents interested in reducing their impact on the environment. Graywater systems cannot be installed without prior approvals and permits from the city's Environmental and Community Development Department. http://www.ci.malibu.ca.us/index.cfm?fuseaction=detailgroup&navid=274&cid=2949.

The City of **Santa Monica** has an incentive-based program to encourage graywater projects. The city provides discounts on sewage bills for installing graywater systems and has implemented a grant program to provide partial funding for innovative landscaping project that incorporate graywater systems and other water-saving features.

The city also provides fact sheets about graywater regulations and additional resources about constructing graywater systems, requesting rebates, or receiving general assistance. http://www.smgov.net/Departments/OSE.

The **Irvine Ranch Water District** uses 18 million gallons per day of recycled water to cover 80 percent of all business and community landscaping needs including parks, golf courses, school grounds, and gardens. In 2000, the Lakeshore Towers' dual-plumbed office complex became the 15th building within the IRWD service area to use recycled water for toilet flushing. http://www.lakeshoretower.com.

The **Orange County Water District's** Groundwater Replenishment (GWR) System is the largest water purification project of its kind in the world and will help increase Orange County's water independence by providing a locally controlled, drought-proof supply of safe, high-quality water. The first phase of the system cost $480 million to build. Initially operational at 70 million gallons per day, it generates enough pure water to meet the needs of 500,000 people. The water exceeds all state and federal standards and provides water quality similar to, or better than, bottled water. The GWR System can produce purified water for approximately $550 per acre-foot, which is less than the cost of desalinization.

Additionally, the GWR System will save additional funds in the future by improving the quality of the water in the Orange County groundwater basin. This water quality improvement takes place when the new purified water, low in minerals, mixes with existing groundwater, lowering the average mineral content of Orange County's water. Lowering the amount of minerals in the water or reducing water hardness will decrease maintenance costs for Orange County's residents and businesses by extending the life of water heaters, boilers, cooling towers, and plumbing fixtures. http://www.gwrsystem.com.

The Serrano development in **Placer County** is one of the first master-planned communities to use recycled water for large-scale residential lawn watering. Recyled water is used to water common areas, golf courses, an elementary school's landscaping, and the front and back yards of more than 3,400 homes.

Due to the success of Serrano, the **El Dorado Irrigation District**, which is now saving millions in treatment costs and reduced discharges, is asking that new developments adopt similar programs whenever feasible. Homeowners save on their water bills as well. http://www.serranoeldorado.com/about-1b.html.

Resources

The **California Department of Water Resource's Office of Water Use Efficiency and Transfers** has a graywater guide, based on California Graywater Standards, for using graywater in home landscaping. http://www.owue.water.ca.gov/docs/graywater_guide_book.pdf.

Oasis Design has a web site that provides an overview of graywater systems and will help you to determine the suitability of a graywater system for your property. http://www.oasisdesign.net/greywater/index.htm.

The **Arizona Department of Environmental Quality** (ADEQ) has issued regulations for all types of reclaimed water. The regulations include new guidelines for the use of residential graywater. Written in nontechnical terms, the regulations make it very simple and affordable for the resident to use graywater, saving money and our valuable water. http://www.watercasa.org/brochure.php.

The **State of California** convened a task force in 2002 to recommend ways to increase California's supply of recycled water and has set a goal to provide enough safe recycled water for the needs of up to 1.5 million Californians by 2007. The recycled water task force final report, *Water Recycling 2030 Recommendations of California's Recycled Water Task Force* (June 2003) is available at: http://www.owue.water.ca.gov/recycle/taskforce/taskforce.cfm.

California's State Water Resources Control Board's Water Recycling Funding Program's mission is to promote the beneficial use of treated municipal wastewater (water recycling) in order to augment fresh water supplies in California by providing technical and financial assistance to agencies and other stakeholders in support of water recycling projects and research. The purpose of the WRFP is to promote water recycling by providing technical and financial assistance to local agencies and other stakeholders in support of water recycling projects and research. Currently, the WRFP administers 49 construction projects and 33 facilities planning studies. http://www.swrcb.ca.gov/recycling.

Related Strategies

W.2.1 Water Efficient Landscaping

Endnotes

1. DWR. 1995. *Graywater Guide: Using Graywater in Your Home Landscape.* Sacramento: Department of Water Resources. http://www.owue.water.ca.gov/docs/graywater_guide_book.pdf.
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EFFICIENT WASTEWATER TREATMENT

Wastewater treatment can represent a major portion of total local government energy consumption. By operating plants efficiently, retrofitting existing plants, and designing efficient new plants, cities and counties can save energy and money. Variable speed drives and efficient motors are typical technologies that increase energy efficiency. Water conservation also will reduce the volume of wastewater flowing to the plant, consequently reducing energy used in plant operations.

Wastewater treatment generates methane, which can be used to power the treatment plant, or some nearby facility. Methane is over 20 times more effective in trapping heat in the atmosphere than carbon dioxide (CO_2).[1] Efforts to prevent or utilize methane emissions can provide significant energy, economic, and environmental benefits. Communities should explore the development of this energy resource if it is not already being tapped.

Governor Schwarzenegger has directed the Department of Water Resources to develop a statewide plan to reduce water use by 20 percent by 2020. The state's green building code calls for a similar reduction in water demand.

General Plan Language Ideas

» The Public Works Department shall undertake regular audits, implement cost-effective retrofit measures, and perform regular maintenance to reduce energy use (kWh/million gallons processed) by at least 10 percent by [date].

» In order to reduce the amount of wastewater to be treated, the City/County shall adopt a water conservation program, including requirements that new buildings include water-conserving fixtures and existing buildings install water conserving fixtures upon resale. The objective will be to reduce wastewater flow by ___ percent by [year].

Implementation Ideas

» **Perform an energy audit and implement recommendations.** An audit shall define an existing water and energy balance and will identify operational and facility improvements to reduce energy costs. Include funds for regular upgrading of equipment in the capital improvement budget. The California Energy Commission's Energy Partnership Program can help with the cost of the audit.

» **Perform routine maintenance.** Annual testing of pumps and motors by trained operators at the plant can detect inefficiencies, which can then be repaired. Include the cost of such maintenance and operator training in the budget.

» **Integrate energy efficiency into new or expanded plant design.** Energy efficiency should be considered throughout the design of any new treatment plant or expansion of existing plants. The lifecycle costs of energy efficient technologies can be calculated to show how such technologies will save money in the long run.

» **Install a data management system.** A computerized system that optimizes plant operation and automatically tracks plant operations can be used to identify problem areas and fine tune operations to improve efficiency.

» **Implement water conservation programs.** Water conservation programs that target indoor (nonlandscaping) water use will result in a reduction in the amount of wastewater that must be treated. See strategies B.1.2 Going Beyond State Building Energy Standards, B.1.4 Retrofitting Residences, B.1.5 Retrofitting Commercial Buildings, and the Urban Water Conservation Background section.

Energy Savings

Energy savings from variable-frequency drives can be significant. Even a small reduction in motor speed will highly leverage energy savings. Variable-frequency drives can reduce a pump's energy use by as much as 50 percent. A variable frequency drive controlling a pump motor that usually runs less than full speed can substantially reduce energy consumption over a motor running at constant speed for the same period.[2]

Environmental Benefits

Wastewater treatment plants can contribute to air pollution emissions in two primary ways: 1) direct emissions from treatment processes, sludge incineration, cogeneration, and other on-site processes; and 2) emissions from off-site power plants generating electricity to serve the plant. Improving the energy efficiency of the plant can reduce emissions both on-site and off-site.

Generating electricity from wastewater treatment plant methane can reduce overall plant emissions and its contribution to climate change.

Reducing water consumption has numerous environmental benefits, including improving wildlife habitats, maintaining groundwater supplies, and reducing the amount of energy used to pump water across great distances, over mountains, and through treatment facilities.

Economics

For the variable speed drive example in the Energy Savings section, a 25 horsepower motor running 23 hours per day (2 hours at 100 percent speed; 8 hours at 75 percent; 8 hours at 67 percent; and 5 hours at 50 percent) a variable-frequency drive can reduce energy use by 45 percent. At $0.10 per kilowatt hour, this saves $5,374 annually. Because this benefit varies depending on system variables such as pump size, load profile, amount of static head, and friction, it is important to calculate benefits for each application before specifying a variable-frequency drive.[3]

The city of Redlands Municipal Utility Department installed a 970 kW cogeneration system using landfill gas that was previously flared. The electricity and waste heat from cogeneration is used at the adjacent wastewater treatment plant. The city upgraded the plant to tertiary wastewater treatment so that it can supply recycled water to customers and meet all discharge requirements of the Regional Water Quality Control Board. The cogeneration system will offset the increased energy used for tertiary treatment. The $1.5 million dollar loan had a simple payback period of 2.3 years. The remaining $242,500 for the project was provided as a rebate from Southern California Edison. http://www.energy.ca.gov/efficiency/partnership.

Programs in Operation

There are 242 sewage wastewater treatment plants in California. About 38 megawatts of electrical power is generated from 10 existing sewage wastewater treatment plants. There are 12 sewage treatment plants that utilize the biogas to produce hot water or heat the digester. The rest of 220 sewage wastewater treatment plants either don't recover biogas produced from anaerobic digester or do not have anaerobic digesters on site. About 36 megawatts of electrical potential could be recovered from the remaining 220 sewage wastewater plants.[4]

The City of **Santa Rosa's** wastewater treatment and pumping plants are some of its biggest energy consumers. In 2001, the city began to improve the efficiency of its Laguna Wastewater Treatment Plant. It received a one million dollar loan to install two energy efficient aeration blowers and controls, which save an estimated $123,000 annually in reduced energy costs. Since this initial loan, the city received a subsequent loan of $488,000 to upgrade the pumps at the North Reclaimed Wastewater Station and Rohnert Park Reclaimed Wastewater Pump Station plant. These stations pump the reclaimed wastewater from the Laguna Plant to commercial and agricultural users, reducing the city's annual bills by approximately $70,000. Simple payback for all of the projects was 8.2 years. http://www.energy.ca.gov/efficiency/partnership.

Resources

The **State Water Resources Control Board's Division of Financial Assistance** administers the financial assistance programs that include loan and grant funding for construction of municipal sewage and water recycling facilities. http://www.swrcb.ca.gov/water_issues/programs/grants_loans.

The **California Energy Commission's Energy Partnership Program** provides free energy audits of wastewater treatment plants (up to $20,000) and low-interest loans to pay for energy-saving projects. http://www.energy.ca.gov/efficiency/partnership.

The **U.S. Environmental Protection Agency's Office of Wastewater Management** (OWM) promotes compliance with the requirements of the Federal Water Pollution Control Act. OWM is home to the Clean Water State Revolving Fund, the largest water quality funding source, focused on wastewater treatment systems, Nonpoint source projects, and estuary protection. http://www.epa.gov/owm.

Related Strategies

B.1.2 Going Beyond State Building Energy Standards
B.1.4 Retrofitting Residences
B.1.5 Retrofitting Commercial Buildings

Endnotes

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2. California Energy Commission Wastewater Treatment web site. Accessed July 2009. http://www.energy.ca.gov/process/water/wastewater_treatment.html.
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ENERGY AWARE PLANNING GUIDE

INTRODUCTION

COMMUNITY ENERGY STRATEGIES

This section presents ways cities and counties can manage their energy use and energy supplies beyond those described in the transportation, land use, building and water categories of the rest of this guide. Examples include distributed renewable generation on residential, commercial and municipal facilities; procuring green electricity; promoting the local food movement; and reducing solid waste. Particular focus is given to identifying and financing renewable sources of energy. A number of innovative community energy strategies are being used in California to generate and finance alternative sources of energy, including:

» **Regional energy offices.** Some communities have set up regional entities to share staff and expenses in their energy reduction efforts. These regional energy offices have been able to identify funding, coordinate technical assistance, and assist in the implementation of energy efficiency programs that might otherwise have been off the radar screen of their constituents.

» **Locally produced energy sources.** Community Choice Aggregation (AB 117), signed into law in 2002, allows cities and counties, or groups of them, to procure or generate electricity for consumers within their jurisdictions (investor owned utilities continue to provide transmission and distribution services).

Solar Photovoltaic panels on the roof of the Moscone Center.
Photo: San Francisco Public Utilities Commission.

» **Financial assistance programs.** In 2008, several communities set about establishing finance assistance programs to help constituents overcome the barrier to installing renewable energy systems and energy efficiency upgrades through municipal financing recovered on property taxes.

Community energy strategies are particularly important given that electricity is currently the second largest source of greenhouse gas (GHG) emissions in California (after transportation). Reducing the amount of GHGs generated from electricity will be essential for meeting the requirements of AB 32, California's Global Warming Solutions Act of 2006.

Community Strategies

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COMMUNITY ENERGY AUTHORITIES

Some local governments may wish to undertake a very proactive role in managing energy efficiency, advancing renewable energy options and even in generating electricity at the local level. This requires strong organizational frameworks that can directly focus on a complex subject that affects all local governments. The following are three examples of organizational frameworks communities are using to manage and/or produce local energy supplies.

1. Community Energy Authority

In 1984 the California legislature enacted the Community Energy Authority (CEA) Act (Government Code 52000-52012). Its purpose was to provide a means for a city or county (or group of them through a joint powers agreement) to plan and implement a comprehensive energy strategy to encourage energy efficiency and conservation, and minimize the impact of future energy price increases. A CEA can be given bonding authority to generate the initial funds for renewable or efficiency projects.

2. Community Choice Aggregation

In 2002, the California legislature enacted AB 117 Community Choice Aggregation (CCA) in California. CCA legislation allows cities and counties (or groups of them) to become the electric commodity provider for the electricity customers within their jurisdictions. The legislation allows the local governing body the authority to procure electricity from any source, including renewable sources, that can be transmitted through their existing utility. All customers must be given the chance to "opt out" of the program and remain customers of their existing utility. CCA can only occur in the service territories of the three investor-owned utilities (IOU) in California (Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric) that will continue to provide transmission, distribution, billing and meter reading services.

Since 2003, the California Public Utilities Commission (CPUC) has been formulating the rules for CCA (R.03-10-003). As of early 2009, the CCA has yet to be successfully implemented although the San Joaquin Valley Power Authority near Fresno filed an implementation plan in 2008 with the CPUC, and Marin County has developed an implementation plan.

3. Regional Energy Offices

Some larger cities and counties have been able to sustain energy offices and/or staff due to their size (Los Angeles County), owning a municipal utility (San Francisco), or based upon their commitment (Santa Monica and Berkeley). But for many local governments, maintaining an energy focus except during times of crisis has not been possible. Regional energy offices have been established in Humboldt, San Diego and Ventura counties to leverage energy resources and staff for greater benefit among residents, businesses, and public institutions countywide.

General Plan Language Ideas

» The City/County shall investigate establishing a Community Energy Authority for the purpose of implementing a comprehensive energy strategy.

» The City/County shall investigate the feasibility of creating a Community Choice Aggregation program to provide electricity to its residential, commercial and institutional constituents. The feasibility study should include the cost of providing ____ percent renewable content in the CCA electricity supply.

» The City/County shall investigate with neighboring jurisdictions establishing a regional energy office to share the cost of maintaining staff that can search out funding and technical assistance programs and help member jurisdictions implement energy efficiency, demand side management and renewable generation programs.

Implementation Ideas

» **Fund a Community Energy Authority feasibility study**.

» **Fund a feasibility study for a Community Choice Aggregation program**.

» **Create a regional committee to investigate formation of a shared energy office**. Operational funding mechanisms could include a proportion of utility savings of the municipal facilities that benefit from the services of the office.

Examples Of Energy Savings And Benefits

In its first five years, the Ventura County Regional Energy Alliance (VCREA) supported 107 energy efficiency projects by public agencies and nonprofit organizations that save more than 12.2 million kWh. During the 2006-2008 program cycle alone, 1,897 KW of demand reduction was achieved.[1]

The California Center for Sustainable Energy (CCSE) operated the Tax-Exempt Customer Incentive Program for military, public or private K-12 schools, and local governments in the 2006-2008 public goods charge cycle. As of the end of 2007, more than 46 million kWh (89 percent of the goal) and 730,000 therms (760 percent of the goal) had been committed under the program.[2]

Environmental Benefits

The California Center for Sustainable Energy (CCSE) operates programs in the San Diego area. From 2004 through 2008, CCSE has sequestered or reduced 28,010 metric tons of CO_2e (equivalent to 79 million kWh of electricity) with the Cool Communities Shade Tree Program, the California Solar Initiative, the Solar Water Heating Program, and a group of energy efficiency programs. The CCSE also operates the Self-Generation Incentive Program (SGIP) in San Diego Gas and Electric's service territory. (SGIP carbon savings are not included in the number above because the program's benefits are still being assessed.)

Economics

A study sponsored by the California Energy Commission's Public Interest Energy Research (PIER) program worked with 12 California cities and counties that were interested in using Community Choice Aggregation as a way to increase the amount of renewable energy generated and consumed in their communities. Capital financing is less costly for public agencies than private companies such as utilities because of their tax-free bonding authority, lack of investor dividend payments, and no income tax liability. As a result, the study found it was feasible for CCAs to provide a higher renewable content (40 percent) to their customers at the same or lower rate as the IOUs' required renewable content (20 percent).

In its 2006-2008 public goods charge cycle, the Ventura County Regional Energy Alliance through its utility partnership program brought in almost $1.1 million in incentives for 72 energy efficiency projects in the county. The projects are estimated to save the public sector agencies and nonprofits almost $1 million per year in avoided utility costs. These incentives leveraged additional local dollars to complete the cost of improvement expenditures, a portion of which were directed to local suppliers, vendors, and contractors.[3]

Programs In Operation

The **San Joaquin Valley Power Authority** (SJVPA) is the first entity in the state to file a community choice aggregation implementation plan with the California Public Utilities Commission (CPUC). SJVPA is a joint powers authority of Kings County and 11 cities in the Fresno area. As the first potential CCA in the state, SJVPA's efforts have helped define the relationship between CCAs and investor owned utilities, and the CPUC rulings that will govern those relationships. The SJVPA plans to phase in CCA service to municipal accounts first; then to large commercial and industrial customers; then to medium commercial customers; and finally to small commercial, agricultural and residential customers. As of March 2009, the SJVPA had not started serving customers. http://www.communitychoice.info/sjvpa.

The **Marin Energy Authority** (MEA) is a joint powers authority formed to collectively study, promote, develop, and manage energy programs to address climate change. The MEA includes Marin County and eight cities located in the county. The MEA is the first joint power agency established in the state of California to reduce greenhouse gas emissions in compliance with California's global warming law, AB 32. Marin Clean Energy is a proposal under consideration by the Marin Energy Authority to directly buy renewable power collectively. If enacted, Marin Clean Energy would reduce Marin's greenhouse gas emissions by initially providing twice as much renewable power as PG&E. http://marincleanenergy.info.

The **California Center for Sustainable Energy** (CCSE) is a nonprofit corporation that helps residents, businesses, and public agencies save energy, reduce grid demand, and generate their own power through a variety of rebate, technical assistance, and education programs. CCSE evolved from the San Diego Regional Energy Office, which was created in the 1990s. CCSE provides the community with objective information, research, analysis, and long-term planning on energy issues and technologies. CCSE's mission is to foster public policies and provide programs, services, information, and forums that facilitate the adoption of clean, reliable, renewable, sustainable, and efficient energy technologies and practices. http://energycenter.org.

The **Ventura County Regional Energy Alliance** (VCREA) is a joint powers public agency that seeks funds to augment local government energy efficiency budgets with additional resources such as utility ratepayers' funds and grants. In addition to direct assistance to identify and implement energy efficiency projects, VCREA publishes a bimonthly newsletter, hosts technical training seminars, supports community events, and maintains a local energy resource center, and provides customer information to libraries, Chambers of Commerce, and public agencies. Many services are specifically directed to local public agencies as well as nonprofit organizations. VCREA's governing board grew from four municipal members initially to nine diverse public member agencies as of 2009 and has become a mechanism for local elected officials, business, and community leaders to join forces and take action that leads to greater public awareness of energy efficiency and reliability. http://www.vcenergy.org.

The **Redwood Coast Energy Authority** (RCEA) develops and implements sustainable energy initiatives to reduce energy demand, increase energy efficiency, and advance the use of clean, efficient, and renewable resources available in the region. RCEA was formed in 2003 as a Joint Powers Authority representing seven municipalities (the Cities of Arcata, Blue Lake, Eureka, Ferndale, Fortuna, Trinidad, and Rio Dell) and Humboldt County. The Redwood Coast Energy Information Center serves as a one-stop-shop for energy efficiency information for residential, commercial/industrial, and public agency energy users in Humboldt County. http://www.redwoodenergy.org.

Resources

The **San Joaquin Valley Power Authority** maintains a web site on Community Choice Aggregation. http://www.communitychoice.info/about.

Information about the California Energy Commission's PIER Community Choice Aggregation project is available on the **Local Government Commission's** web site at http://www.lgc.org/cca/index.html.

The **California Energy Commission** web site hosts the final report for the PIER Community Choice Aggregation program (CEC-500-03-004). Appendices include reports on the CPUC decisions, sample data request letters for the utilities, a CCA implementation plan template, fact sheet, guidebook, and a sample business plan. http://www.energy.ca.gov/2008publications/CEC-500-2008-091.

Related Strategies

C.1.2 Community Energy District Financing
C.1.3 Cool Communities
C.2.1 Renewable Energy Resources
C.2.2 Distributed Generation

Endnotes

1. VCREA. 2008. *Ventura County Regional Energy Alliance 2008 Annual Report.* Ventura: Ventura County Regional Energy Alliance. http://www.vcenergy.org.
2. CCSE. 2007. *California Center for Sustainable Energy 2007 Annual Report.* San Diego: California Center for Sustainable Energy. http://digital.virtualmarketingpartners.com/vmp/CCSE/annual-report-08.
3. VCREA. 2008.

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COMMUNITY ENERGY DISTRICT FINANCING

According to the California Air Resources Board, about one-third of the greenhouse gases (GHG) emitted in California come from the electricity and natural gas sector, most of which is related to building energy use.[1] In order to meet the state's AB 32 goal of reducing GHG emissions by 2050, energy use in existing buildings must be dramatically reduced.

The largest impediment to implementing energy efficiency or renewable generation measures in existing structures has been the high initial cost, even if the investment will generate net cost savings in the future. Municipalities have worked to overcome this impediment by providing financing to property owners to make improvements, which the owner then repays over time via a voluntary contractual assessment on their property tax bill.

In 2007, the city of Berkeley developed a plan to set up an energy financing district to provide the initial funding that home and business owners would then repay on their property tax bills over a designated time period. Berkeley enacted a Mello-Roos Special Tax through which to repay the funds rather than a contractual assessment. This tax commitment stays with the property so that upon sale it becomes the responsibility of the new owner who will reap the continuing benefit of the energy upgrade. AB 811 was enacted to allow non-Charter cities and counties to implement this type of program.

The money to operate these programs and to provide the loans has come from various sources. The city of Palm Desert used money from its General Fund. Others have approved bond financing (Boulder County, Colorado) or sought private financing (Berkeley). Sonoma County is using Treasury notes until a critical mass of loans have been made, at which time bonds will be issued. Regardless of where the program money comes from, the property assessment should cover all the costs associated with operating the program (see the Economics section below).

AB 811

AB 811, passed in 2008, authorized municipalities to implement certain innovative finance strategies to assist property owners in improving the energy efficiency of and adding distributed renewable energy generation to their buildings.

The municipality provides funds to the building owner to finance the energy improvement. In return, a voluntary contractual assessment is added to the property tax bill for a certain period of time. This assessment stays attached to the property even if the building is sold.

General Plan Language Ideas

» The City/County shall adopt an energy financing district program to help local residents and business owners install equipment to improve their buildings' energy efficiency and/or to generate clean, renewable energy. The program shall be cost-neutral to the City/County. Staff shall investigate whether to join with other communities in a program or to do this program independently.

Implementation Ideas

There are several steps to adopting an AB 811 program:

» **Adopt a resolution of intention.** The resolution serves as notice to the community that an energy district financing program is under investigation.

» **Commission a staff report and public hearing.** The staff report should include whether the program should be independently operated, carried out under a joint powers authority with neighboring jurisdictions, or join the statewide effort by California Communities (see Resources). The report should identify and prioritize financing sources, and ensure that the program costs can be recovered by the contractual assessment payments.

» **Adopt a resolution approving report and authorizing contracts and/or sale of bonds.**

Energy Savings

While California has the strictest energy standards in the country for new buildings, existing building stock, much of which was built before any energy standards, could use energy more efficiently. Contractual assessment financing district programs will increase the number of energy efficiency and renewal energy projects on existing buildings.

Energy efficiency is usually less expensive and more cost-effective than renewable energy projects, so it generally

Potential Legal Issues with Community Energy District Financing

AB 811 and Community Energy District Financing have raised some legal questions:

Is it appropriate to provide public funding for improvements that benefit private property owners? AB 811 states that there is a tangible public benefit to energy efficiency improvements to privately-owned buildings.

- Do the property tax increases associated with funding community energy districts violate Proposition 218? **Proposition 218, passed in 1996, requires voter approval of all taxes and most other charges on property owners. Jurisdictions implementing these programs feel there is no conflict, since the AB 811 property tax assessment is voluntary.**

- Who owns the renewable energy or carbon credits associated with AB 811 funded energy improvements? Do they belong to the property owners, the city/county providing the funding, the rebate providers, or the financers? **In Sonoma County, the decision was made that the County, the Water Agency and the Transportation Authority would jointly own the credits and would apply them toward the countywide reduction goals.**

- Can property owners choose to place a tax lien on their property that is superior to an existing mortgage on the property? **Cities and counties that currently operate these programs advise participants to check with their lenders on this issue. Some require commercial property owners to obtain consent and require residential property owners to notify lenders. This is programmatic rather than legislative.**

makes sense to undertake efficiency improvements first, or to combine them with renewable energy to reduce payback times. Some financing district programs require minimum energy efficiency compliance before participation is allowed. For example, Berkeley requires all properties to meet the standards of its residential energy conservation ordinance. Most, however, simply encourage investment in energy efficiency in advance of renewable energy improvements.

Environmental Benefits

AB 32 requirements for addressing greenhouse gas emissions from the building sector will be impossible to meet without addressing existing building stock. AB 811 programs help to overcome the hurdle of initial investment costs for efficiency improvements. In Sonoma County, building energy efficiency represents 12 percent of its community greenhouse gas reduction goal for 2015.

Economics

Many energy efficiency projects have payback periods of less than five years. Renewable energy installations have longer paybacks. As the cost of electricity rises (each of the investor-owned utilities asked for double digit rate increases in 2008), both kinds of investments will become more cost effective. Ideally, the annual contractual assessment will be less than or equal to the utility energy savings of any individual project. After the assessment has been completely repaid, the energy savings continue for the property owner.

There are costs to a local government to develop and operate a district financing program including administration, district formation and validation, bond issuance (if bonds provide the financing), application processing, project verification, and a debt reserve fund (in case of default). All of these costs should be factored into the repayment schedule so that the program pays for itself.

These programs can facilitate green job development; at a minimum, the installation of the measures will be local, stimulating local economic growth:

Programs In Operation

Berkeley's Financing Initiative for Renewable and Solar Technology (FIRST) program is loosely based on "underground utility districts" where the city serves as the financing agent for a neighborhood when utility wires are moved underground. The city will provide the funding from a bond fund that it will repay through 20-year assessments on participating property owners' tax bills. The assessment is only placed on property owners who voluntarily use the program. The city requires all participants to comply with its Residential or Commercial Energy Conservation Ordinance (see strategies B.1.4 and B.1.5). http://www.berkeleyfirst.renewfund.com

Photovoltaic system on the first home in Berkeley to take advantage of the Berkeley FIRST program.

The City of **Palm Desert's** Energy Independence Program (EIP) is designed to help property owners save energy. The city has established a goal to reduce electric and natural gas energy consumption by 30 percent. Palm Desert intends to initially fund EIP with $2.5 million for energy reduction investments that might not have otherwise been possible, with a maximum aggregate amount of $25 million. The money is coming from the city's General Fund. The city will make loans to property owners within the city to finance the installation of energy improvements. Property owners in the city will repay EIP Loans through an assessment levied against their property which is payable in semiannual installments on property tax bills. http://www.cityofpalmdesert.org/Index.aspx?page=484.

The **Sonoma County** Energy Independence Program (SCEIP) allows Sonoma County property owners to take loans from the county to install water conservation, energy efficiency and renewable energy improvements. The loans are paid back along with the participants' property taxes over a period of up to 20 years. Because the loans are paid back, with interest, the program is cost-neutral. The SCEIP offices opened in March 2009 and had received $6.5 million in requests by the end of May. http://www.sonomacountyenergy.org.

The **ClimateSmart Loan Program** provides a voluntary mechanism for commercial and residential property owners to obtain financing for renewable energy and/or energy efficiency improvements to properties in Boulder County, Colorado. The program requires participants to pay for its administration so that there is no additional tax burden on those who choose not to participate. In order to accomplish this, residential loan applicants submit a $75 application fee via a web interface at the time they apply. Voters approved $40 million in bonding capacity for the program. http://www.beclimatesmart.com.

Resources

The **California Statewide Communities Development Authority** (California Communities) is a joint powers authority sponsored by the California State Association of Counties and the League of California Cities. In the fall of 2009, the California Communities is expected to start a statewide program to help local governments develop and operate AB 811-type programs. Renewable Funding and the Royal Bank of Canada Capital Markets have been selected as the administrative and financing team for the project. Statewide program benefits are expected to include reducing the legal, administrative, and financing burden on a city or county; achieving economies of scale to reduce overall cost to the local government and property owner; and creating a standard program design that is easier to market and replicate. http://www.cacommunities.org.

Related Strategies

B.1.4 Retrofitting Residences
B.1.5 Retrofitting Commercial Buildings
C.1.1 Community Energy Authorities

Endnotes

1. California Air Resources Board, Greenhouse Gas Inventory, using 2004 estimates for electricity production and household natural gas use. http://www.arb.ca.gov/cc/inventory/archive/tables/ghg_inventory_ipcc_90-04_all_2007-11-19.pdf.

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COOL COMMUNITIES

Buildings, streets, and other paved surfaces – and a consequent lack of vegetation – dominate modern urban areas. Because those surfaces absorb sunlight which is then reradiated as heat, the local climate becomes warmer – a typical city is about 5°F hotter than the surrounding rural area on a clear summer afternoon – in what is called the "urban heat island effect."[1] This results in increased electricity use for cooling as well as reducing the overall habitability of the city. Researchers have studied ways to reduce the urban heat island effect, and have identified vegetation – particularly shade trees, reflective "cool roofing" materials, and "cool pavements" as effective mitigation strategies.

Trees

Trees and vegetation lower surface and air temperatures by providing shade and through evapotranspiration, where plants release moisture through their leaves. Shaded surfaces may be 20-45°F cooler than the peak temperatures of unshaded materials. Evapotranspiration, alone or in combination with shading, can help reduce peak summer temperatures by 2-9°F.[2]

Trees and vegetation are most useful as a mitigation strategy when planted in strategic locations around buildings or to shade pavement in parking lots and on streets. Researchers have found that planting deciduous trees or vines to the west is typically most effective for cooling a building, especially if they shade windows and part of the building's roof.[3]

Tree shaded neighborhoods are cooler and use less energy than unshaded ones.

Green Roofs

A green roof, or rooftop garden, is a vegetative layer grown on a rooftop. Green roofs provide shade and remove heat from the air through evapotranspiration, reducing temperatures of the roof surface and the surrounding air. On hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 90°F warmer.[4]

Cool Roof

Cool roofs are highly reflective and emissive (releasing infrared energy) materials that stay 50-60°F cooler in the summer sun, thereby reducing energy costs, improving occupant comfort, cutting maintenance costs, increasing the life cycle of the roof, and contributing to the reduction of urban heat islands and associated smog.[5] In addition, reflective surfaces actually offset global warming. Carbon in the atmosphere traps heat but allows light to pass through. Sunlight striking a dark surface is absorbed and reradiated as heat, while sunlight striking a white surface is reflected back into space. Replacing a 1,000 square foot dark roof with a white roof can offset roughly 10 metric tons of carbon emissions.[6]

Because it reflects the highest proportion of light, bright white roofs have the greatest impact and are appropriate for flat and low-sloping roofs. "Cool color" roofing materials are also becoming available at low additional cost - these materials can have double the reflectivity of their standard counterparts and include tile, metal, and composition shingles. They look the same because the pigments used have the same reflectivity in the visible spectrum, but higher reflectivity in the infrared and near-infrared.

Title 24, California's Building Energy Efficiency Standards, now requires flat roofs to be white roofs, and credit is given for cool colors in some climate zones. The California Air Resources Board is also about to begin crediting roof albedo as a strategy to reduce greenhouse gases under AB 32 implementation.

Cool Pavement

Cool pavement refers to paving materials that reflect more solar energy, enhance water evaporation, or have been otherwise modified to remain cooler than conventional pavements. In typical applications, concrete paving has higher reflectivity than asphalt. For asphalt, the surface wears quickly to the color of the aggregate, so lighter color aggregate is preferred. Research is underway to develop and test cooler paving materials.

The Mayor of Palm Desert on the City Hall's cool roof.

Conventional paving materials can reach peak summertime temperatures of 120-150°F, transferring excess heat to the air above them and heating stormwater as it runs off the pavement into local waterways. Due to the large area covered by pavements in urban areas, they are an important element to consider in heat island mitigation.[7]

General Plan Language Ideas

» The City/County shall commit to developing a strategy to reduce the urban heat island effect of the built environment. The strategy shall be included in the community energy plan [or climate action plan].

Implementation Ideas

» **Adopt a resolution stating the city/county's awareness of and interest in developing a heat island mitigation strategy**.

» **Implement an urban heat island mitigation project** such as a cool roof, green roof, or cool pavement project at a municipal facility. Revise bid specifications to include cool products.

» **Adopt a parking lot shade ordinance** as a cool community strategy that also lowers evaporative emissions from parked cars.

» **Provide incentives, such as density bonuses or expedited permitting, for projects that voluntarily incorporate cool communities strategies**.

» **Include a cool roof or green roof requirement** in the city/county's local green building ordinance.

Energy Efficiency in California

In 1973, Europe used roughly one half as much energy per capita as the United States, yet they weren't freezing and in the dark. How, then, did the Europeans maintain a similar standard of living with half of the energy use intensity? I realized one day that my office used about one kilowatt of energy for lighting, and the hallway between my office and car used about 20 kW. If I turned off all these lights over the weekend, I would save more petroleum than what my car would use. However, it was not an easy task – the light switches were covered with posters and bookcases and had never been turned off. An hour later, after reorganizing and turning off all the switches, I left for home thinking something was hopelessly wrong.

It turns out things were not so hopeless. Energy awareness and efficiency have improved dramatically since the 1970's in California. Between 1975 and 2005, per capita electricity sales in the United States increased by 52 percent, while California increased by only 2.8 percent. The Energy Commission attributes one third of this difference to state energy efficiency standards put into place during this time. For example, refrigerators have progressively grown in size since the late 1970's, yet have managed to improve in efficiency 5 percent every year. Now, refrigerators are larger and have more features, but use one quarter of the energy they would have before standards.

There are still innumerable opportunities for energy savings in the future. Using light-reflecting colors and materials on roofs, known as cool roofs, can decrease the temperature of a building, resulting in up to 20 percent lower electrical demand from air conditioning. Cool roofs also help mitigate the urban heat island effect – a phenomenon where dark colors used in urban areas, such as black asphalt and roofing, absorb solar radiation and generate heat, raising ambient temperatures as much as 10 percent. Simply put, a cool roof will save money on air conditioning bills as well as increase comfort. Other technologies, such as electric motors, air conditioning, lighting, and programmable thermostats, show similar potential.

Historically, energy efficiency upgrades have been the most cost-effective method of reducing energy use and greenhouse gas emissions. While many suggest we need to follow a path towards renewable energy independence – which we must – energy efficiency is an often overlooked solution that should be pursued first for greater and more cost-effective energy use reductions. Energy efficiency is the low hanging fruit. Local governments are in a position to be leaders in these fields and the California Energy Commission is here to help you identify, understand, and benefit from energy efficiency opportunities.

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http://www.energy.ca.gov/commissioners/rosenfeld.html

Energy Savings

Measures that mitigate the urban heat island effect can save energy directly and indirectly. Direct energy savings come from measures that keep buildings cooler, such as cool roofs and shade trees, and reduce the need for air conditioning. Indirect savings come from measures that reduce the ambient temperature in a neighborhood and thus further reduce the need for air conditioning. Indirect measures include cool pavements, cool roofs and evapotranspiration from plants.

During the summer, a typical dark roof is 150-90°F at peak, while cool roofs peak at 100-20°F.[8] A cool roof transfers less heat to the building below, so the building stays cooler and uses less energy for air conditioning. In addition, it radiates less heat thus reducing the local air temperature.

Environmental Benefits

Trees, vegetation, and green roofs can reduce heating and cooling energy use and associated air pollution and greenhouse gas emissions, remove air pollutants, sequester and store carbon, help lower the risk of heat-related illnesses and deaths, improve stormwater control and water quality, reduce noise levels, create habitats, improve aesthetic qualities, and increase property values.

Cool pavements can indirectly help reduce air pollution and greenhouse gas emissions. Depending on the technology used, cool pavements can improve stormwater management and water quality, increase surface durability, enhance nighttime illumination, and reduce noise.

Reflective urban surfaces and shade trees reduce smog. A national laboratory study simulated the cooling achieved by increasing the solar reflectance of roofs and roadways in the Los Angeles Basin. The results showed a 4°F cooling by noon, when smog is forming rapidly. Putting these results into the Los Angeles smog model then predicted a reduction in population-weighted smog of 10-20 percent.[9]

Widespread implementation of these strategies also provides additional benefits. For example, a single cool roof will mainly result in benefits to the building owner and occupants. Community-wide cool roof installations, though, will provide savings to the building owner and occupants and to the community at large, as a large number of cool roofs can reduce air temperatures, resulting in multiple benefits associated with cooler summertime air.[10]

Economics

Through direct shading and evapotranspiration, trees reduce summer cooling energy use in buildings at about one percent of the capital cost of avoided power plants plus air-conditioning equipment. Cool surfaces are more effective than trees and cost little if color changes are incorporated into routine reroofing and resurfacing schedules. In addition, the results from light-colored surfaces are immediate, while it may be 10 or more years before a tree is large enough to produce significant energy savings.[11]

Although the benefits of urban forestry can vary considerably by community and tree species, they are almost always higher than the costs. A study of five cities' urban forestry programs found that, on a per-tree basis, the cities accrued benefits ranging from about $1.50-$3.00 for every dollar invested. These cities spent roughly $15-$65 annually per tree, with net annual benefits ranging from approximately $30-$90 per tree.[12]

While the initial costs of green roofs are higher than those of conventional materials, building owners can help offset the difference through reduced energy and stormwater management costs, and potentially by the longer lifespan of green roofs compared with conventional roofing materials.

A California study found that cool roofs provide an average yearly net savings of almost 50 cents per square foot. This number includes the price premium for cool roofing products and increased heating costs in the winter as well as summertime energy savings, savings from downsizing cooling equipment, and reduced labor and material costs over time due to the longer life of cool roofs compared to conventional roofs.[13]

Comparing the costs of cool pavements with those of conventional paving materials is difficult. The cost of any pavement application varies by region, the contractor, the time of year, materials chosen, accessibility of the site, local availability of materials, underlying soils, size of the project, expected traffic, and the desired life of the pavement.

Programs In Operation

Cool roofs have been required since 2005 for new commercial flat roof construction under California's Title 24. The 2008 update to Title 24 will include some requirements for sloped roofs, residential construction, and some reroof projects.

California Center for Sustainable Energy's Cool Communities Shade Tree (CCST) Program has had direct energy benefits. The program provided 17,398 shade trees since 2006, which will result in an electric demand reduction of 2,958 kW and a total energy savings of 2.7 million kWh per year on average over the next 20 years. Since its inception in 2002, CCST has provided hands-on education and more than 35,000 trees to thousands of residents in San Diego County. http://energycenter.org.

Since 1990, the **Sacramento Municipal Utility District (SMUD),** in collaboration with the Sacramento Tree Foundation, has planted more than 450,000 trees in the Sacramento area. Together they provide expert advice on tree selection and planting techniques, as well as healthy trees from four to seven feet tall and stakes, ties, fertilizer, and tree delivery at no cost. SMUD has developed a web-based Tree Benefits Estimator that will assess the amount of energy savings and pollution removed when mature trees are planted in urban and suburban settings. In addition, SMUD funds another urban heat-island mitigation effort, Community Shade. The program offers free 15-gallon container trees for planting in public areas such as parks, playgrounds, and schools. http://www.smud.org/en/residential/trees/Pages/index.aspx.

Since 1983, an ordinance in **Sacramento's** zoning code has required that enough trees be planted to shade 50 percent of new or significantly altered parking lots after 15 years of tree growth. Sacramento's Parking Lot Tree Shading Design and Maintenance Guidelines: http://www.cityofsacramento.org/planning/long-range.

In 2001, **Portland, Oregon** modified its zoning code to include an "eco-roof development bonus" for developers to install rooftop gardens or "eco-roofs." Title 33 of the Zoning Code contains a floor area ratio bonus for projects that install eco-roofs in Portland's central district. The bonus amount depends on the extent of the eco-roof coverage. If the eco-roof covers 60 percent or more of the roof surface, developers can build an additional three square feet for each square foot of green roof. If the green roof covers a lower percent of the surface, the bonus is reduced. Portland's Zoning Code (section 33.510) is available at: http://www.portlandonline.com/auditor/index.cfm?c=28197.

The City of **Chicago** installed a green roof on its city hall that includes 20,000 plants, shrubs, grasses, vines, and trees. The city expects to save directly more than 9,270 kWh per year of electricity and nearly 740 million British thermal units (Btu) per year of natural gas for heating. This energy savings translates into about $3,600 annually, and savings will increase with higher energy prices. In addition to assessing energy impacts, the green roof has been designed to test different types of rooftop garden systems, success rates of native and nonnative vegetation, and reductions in stormwater runoff. This city hall green roof has helped to raise the visibility of green roofs and to increase public understanding of them.

After the success of its green roof demonstration project, Chicago established green and cool roof grant programs. In 2005, its first year, the program supported 20 green roof installation projects; in 2006, it helped fund four projects. Recipients can use grants for residential, commercial, or industrial buildings.

Resources

The **San Joaquin Valley Power Authority** maintains a web site on Community Choice Aggregation. http://www.communitychoice.info/about.

Information about the California Energy Commission's PIER Community Choice Aggregation project is available on the **Local Government Commission's** web site. http://www.lgc.org/cca/index.html.

The **California Energy Commission** web site hosts the final report for the PIER Community Choice Aggregation program (CEC-500-03-004). Appendices include reports on the CPUC decisions, sample data request letters for the utilities, a CCA implementation plan template, fact sheet, guidebook, and a sample business plan. Web site: http://www.energy.ca.gov/2008publications/CEC-500-2008-091.

Related Strategies

L.3.1 Complete Streets and Street Design
L.3.2 Street Trees

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ENERGY AWARE PLANNING GUIDE C.2.1

RENEWABLE ENERGY RESOURCES

The state of California has adopted a preferred order for meeting future energy needs: efficiency and conservation first, then renewable generation, distributed generation, and finally, clean and efficient fossil fuel generation. California provides resources to implement this “loading order” through public good programs operated and/or overseen by the electric and gas utilities, the California Public Utilities Commission (CPUC), and the California Energy Commission.[1]

California has also enacted legislation to support renewable energy generation through a renewable portfolio standard (RPS) for private utilities overseen by the CPUC (20 percent renewable generation by 2010, with a goal of 33 percent by 2020), and the California Solar initiative, which has a goal of one million solar (photovoltaic and thermal) roofs totaling 3,000 megawatts by 2017. Publicly owned utilities set their own RPS goals recognizing the intent of the legislature to attain a target of 20 percent of California retail sales of electricity from renewable energy by 2010.[2]

The electric utilities publish their Power Content Labels that disclose the percentage of electricity they supply by source (nuclear, natural gas, hydro, wind, solar, geothermal, etc.). This information will provide a city or county with the percent renewable versus nonrenewable electricity it consumes. When combined with electric consumption figures for municipal facilities and for the community as a whole, an estimate of greenhouse gas emissions is possible. Most California utilities can provide community-wide data on request.

Feed-in tariffs offer a price guarantee to eligible renewable generators over a period of time. Feed-in tariffs are in use in Europe (e.g., Germany, Spain, Great Britain) and have increased the amount of renewable energy production there. California is contemplating a feed-in tariff, but has not adopted one yet.

Examples of renewable energy projects include generating electricity from the sun (either photovoltaic systems that convert sunlight to electricity or thermal projects that use sunlight to heat a liquid that then powers an electric turbine), solar water heating, wind, biomass (from organic material such as agricultural or forest waste), biogas (methane from landfills, wastewater treatment or dairy farms), geothermal (steam), or small hydroelectric projects.

Landfill gas extraction for power production in Sonoma County.

Landfill gas extraction for power production in Sonoma County.

Local governments can take actions that can encourage renewable generation in their jurisdictions, or they can create obstacles, such as high permit fees or difficult permit requirements. Communities interested in encouraging renewable generation need to know what the potential resources are and where they are located, and then take action to protect them. For example, several communities in California have mapped the solar potential within their communities in order to estimate the potential for local generation.

Local governments can take an active role in developing renewable energy projects in their communities, through energy district financing programs (strategy C.1.2) or by creating community energy authorities (strategy C.1.1).

General Plan Language Ideas

» The City/County shall identity, protect and develop the renewable energy resources within its jurisdiction and/or control in order to reduce dependence on foreign energy sources, improve the local economy, and reduce the community's impact on global climate change.

Implementation Ideas

» Identify and map the renewable energy resources in the community.

» Remove barriers to renewable energy investments such as streamlining the permit process, standardizing permitting requirements across nearby jurisdictions, and lowering or waiving permit fees.[3]

» Train municipal staff including building inspectors and permitting staff so that renewable projects do not meet with resistance.

» Provide residents and businesses with financial incentives such as rebates and/or low interest loans, or develop an energy district financing program for efficiency and renewable projects (see strategy C.1.2).

PVs on a commercial building in Sacramento.

» Invest in renewable energy projects on municipal buildings and facilities. The city/county can serve as a model for residents and businesses.

» Require solar on some new homes. The state has a goal to have all new homes be zero-net energy (i.e., they generate as much energy as they consume) by 2020, and all new commercial buildings be zero-net energy by 2030. Work with the local utility to identify the best sites for these solar homes.

Energy Savings

Renewable energy projects will not save energy by themselves. However, they will reduce the amount of grid/utility energy that is generated from fossil fuels in California.

Environmental Benefits

The California Energy Commission's analysis of self-generation installations yielded a net reduction in both particulate matter ($PM_{2.5}$) and greenhouse gases when compared to a natural gas fired power plant.[4]

The Sonoma County Water Agency installed photovoltaic panels to help power its operations.

Economics

The Union of Concerned Scientists (UCS) has studied the job development implications of renewable energy for many years. In studies for several states (Colorado, Texas, Washington, Wisconsin), UCS found that various renewable portfolio standards (RPS) requirement amounts (10-20 percent) would generate between 1.8 and 2.8 times as many jobs as an equivalent amount of generation from fossil fuels. UCS found that if a nationwide RPS of 25 percent were enacted, 297,000 new jobs would be created.[5]

The California Energy Commission analysis of the state's Self-Generation Incentive Program (overseen by the California Public Utilities Commission and operated by the investor owned utilities) found that program expenditures resulted in an estimated $1.7 billion in total value added to the state, and more than 15,000 full-time equivalent jobs.[6]

A report by the Center for Energy Efficiency and Renewable Technology found that building the power plants and green infrastructure to meet the 33 percent RPS goal for California by 2020 would put as much as $60 billion into the state's economy and generate between 100,000 and 235,000 new manufacturing, operations and maintenance jobs.[7]

Programs In Operation

The city of **Redlands** Municipal Utility Department installed a 970 kW cogeneration system using landfill gas that was previously flared. The electricity and waste heat from cogeneration is used at the adjacent wastewater treatment plant. The city upgraded the plant to tertiary wastewater treatment so that it can supply recycled water to customers and meet all discharge requirements of the Regional Water Quality Control Board. The cogeneration system will offset the increased energy used for tertiary treatment. http://www.energy.ca.gov/efficiency/partnership.

The city of **Santa Monica** established the Solar Santa Monica program in late 2006. It was intended to fulfill the city's commitment to the Community Energy Independence Initiative that called for "net zero electricity imports" (electricity self-sufficiency) by 2020. To accomplish this goal – requiring nearly 150 megawatts of renewable, efficiency, and clean distributed generation – the City formed Solar Santa Monica. Since the main barrier to solar adoption is its high up-front cost, Solar Santa Monica sought ways to help residents get in "with little or no money down." In its first year, Solar Santa Monica identified and vetted four different organizations prepared to lend for solar installations. The city also has a list of contractors to help participants get the work done. In three years, the amount of solar in Santa Monica tripled. http://solarsantamonica.com.

The city and county of **San Francisco** developed a solar map for the community that includes an estimate of roof size, usable roof size, and photovoltaic potential, electricity cost savings, and carbon savings by address. San Francisco offers incentives ranging from $2,000 to $4,000 for residents and up to $10,000 for businesses on top of what they can get from PG&E. Low-income residents can qualify for an additional $7,000. San Francisco has a goal of 10,000 solar rooftops by 2010. http://sf.solarmap.org.

With funding from the U.S. Department of Energy's Million Solar Roofs Initiative, the **Marin County** Solar Program was able to create a solar potential map of the county. The map uses topographic information to determine the amount of solar insolation an area receives. While not address-specific, the close up maps include streets, and display high to low solar potential. Building orientation and shading can reduce the potential. Marin county is also exploring development of a sustainable safety net as a model for renewable energy development, where renewable-powered (solar, wind, biogas) back-up systems are available during blackouts to provide power to emergency service providers, such as fire and police stations, and to designated emergency gathering places, such as community centers or schools. Web page: http://www.co.marin.ca.us/depts/CD/main/comdev/advance/sustainability/Energy/solar/solarpotent/solar_maps.cfm.

San Francisco has many solar installations on municipal property, including SFO airport.

Resources

The **California Energy Commission** has mapped the potential for large renewable resource development in the state. The solar, wind and geothermal maps are available at http://www.energy.ca.gov/maps.

The **Go Solar California** web site provides consumers with information on rebates, tax credits, and incentives for solar energy systems in California. The California Solar Initiative (CSI) is overseen by the California Public Utilities Commission and operated by PG&E, Southern California Edison and SDG&E, and provides rebates for existing home solar installations. The New Solar Homes Partnership is run by the California Energy Commission and offers incentives for new homes. The site also includes links to equipment providers, installers, tax credit information, and more.

» Web page: http://www.gosolarcalifornia.ca.gov.

» PG&E web page: http://www.pge.com/myhome/saveenergymoney/solarenergy.

» Southern California Edison web page: http://www.sce.com/solarleadership/gosolar/go-solar.htm.

» SDG&E web site: http://www.sdge.com/environment/solar/calSolarInitiative.shtml.

The California Energy Commission offers cash rebates on grid-connected small wind (50 kilowatts or less) and fuel cell renewable energy electric-generating systems through its **Emerging Renewables Program**. Web site: http://www.consumerenergycenter.org/erprebate/index.html.

The California Public Utilities Commission oversees the **Self-Generation Incentive Program** (SGIP) that is implemented by PG&E, Southern California Edison, Southern California Gas Company, and by the California Center for Sustainable Energy in SDG&E's service territory. SGIP provides rebates for wind, microturbine and fuel cell projects.

» California Center for Sustainable Energy: www.sgip.energycenter.org.

» Pacific Gas & Electric: www.pge.com/selfgen.

» Southern California Edison: www.sce.com/sgip.

» Southern California Gas Company: www.socalgas.com/business/selfgen.

Related Strategies

W.4.1 Efficient Wastewater Treatment
C.1.1 Community Energy Authorities
C.1.2 Community Energy District Financing
C.2.2 Distributed Generation
C.5.1 Municipal Procurement

Endnotes

1. California provides incentives for the following kinds of renewable energy projects: solar, wind, geothermal, biomass and small hydroelectric (less than 30 MW).
2. "Each governing body of a local publicly owned electric utility shall be responsible for implementing and enforcing a renewables portfolio standard that recognizes the intent of the Legislature to encourage renewable resources, while taking into consideration the effect of the standard on rates, reliability, and financial resources and the goal of environmental improvement." Public Utilities Code Section 387.
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DISTRIBUTED GENERATION

One of the paths toward greater energy independence in California is through distributed energy resources (DER), or distributed generation. DERs are small-scale power generation technologies (typically in the range of 3 to 10,000 kW) located close to where electricity is used (e.g., a home or business) to provide an alternative to or an enhancement of the traditional electric power system. Examples of DERs include microturbines, fuel cells, combined heat and power, photovoltaic systems, and wind. Benefits of distributed generation include:

» Location-specific grid benefits when facilities are sized correctly. Such systems can avoid transmission and distribution costs and reduce congestion on the grid.

» Greater efficiency. Electricity is lost as it travels over transmission lines. Distributed generation consumed on site has none of this transmission loss.

» Reduced risk of blackouts due to overloading the grid, one of the primary reasons for major blackouts. Distributed generation can also keep vital services such as hospitals, police and fire stations operating during blackouts.[1]

Some DER systems can provide benefits beyond just those associated with generating the electricity locally. Locating DER systems near a fuel source, such as landfill or wastewater treatment gas, will take advantage of this resource that might otherwise be wasted. Colocating facilities, such as one that needs significant electricity and one that has a high heating or cooling load, can maximize the benefit of DER. Combined Heat and Power (Combined Heat And Power) systems, or cogeneration systems, generate electrical/mechanical and thermal energy simultaneously, recovering much of the energy normally lost in separate generation. This recovered energy can be used for heating or cooling purposes, eliminating the need for a separate boiler.

Despite their benefits, high capital costs are presently the norm for many DER technologies and serve as a deterrent to their widespread implementation. However, as production levels and sales increase, it is expected that economies of scale will result in decreased equipment costs.

Another significant issue with DER is the interconnection of the device to the electric utility system. In the United States, common standards for interconnecting DER devices into the utility system do not presently exist. The lack of common standards is considered a barrier to the wide acceptance and installation of DER technologies.

The California Energy Commission has sought to encourage DER by streamlining complicated regulations and the processes involving interconnection, standardization, certification, environmental review, and permits. The agency hopes that developers and consumers will build more of these small plants, thereby lessening the strain on the state power grid and easing the need for larger power plants.

General Plan Language Ideas

» The City/County shall encourage distributed generation within its borders in order to improve reliability, keep local dollars circulating within the community, and avoid using foreign fuels to generate electricity.

» The City/County shall codify the General Plan to cite the benefits of distributed generation as a beneficial practice.

Implementation Ideas

» Provide a point of contact at the Permit/Planning Department for all distributed generation permits including electrical, plumbing, and building into one easy to use packet and develop a timeline for review such that the process is consistent with other types of city/county review.

» Develop a revised zoning ordinance with provisions for the requirements for distributed generation as a permitted use in residential, commercial, industrial, public, open space, agricultural, and in cases as deemed necessary as a conditional use. The standards for noise and equipment should be no more restrictive than that for other similar equipment or appliances. Visual impacts should not be required to comply with conditions any more strict than used for other accessory equipment.

» Develop design standards for typical distributed generation technologies (e.g., rooftop solar photovoltaic panels and water heating, small wind turbines) and provide them to building permit seekers.

» Implement expedited approval procedures for all distributed generation permits less than 10 kilowatts. Standardize approvals for all distributed generation less that 40 kilowatts.

» In concert with planned unit development (including office, residential, and commercial) use nonpropriety software to estimate the feasibility and sizing of distributed generation in the ranges of one to 20 megawatts.

Net Metering

California's net metering law, in effect since 1996, requires utilities to offer net metering to all customers for solar and wind-energy systems up to one megawatt (MW). Under net metering, customers who generate electricity on-site reduce their electricity costs up to the amount they use each month. Net excess generation (NEG) is carried forward to a customer's next bill for up to 12 months. Any NEG remaining at the end of each 12-month period is granted to the customer's utility at no cost.

Excess generation can only be applied to the meter where the generation occurs. For example, a homeowner with a primary residence and a vacation home cannot apply any excess generation at one location to the electric bill at the other location.

In 2008, AB 2466 changed the rules for local governments. Cities and counties can now over-generate at one facility and apply the excess to other municipal accounts. Some municipalities own facilities that have the space to locate large solar arrays but do not have large electric loads, such as land surrounding a water treatment plant. A city could set up a solar farm at such a location, and net the excess generation against the bill at City Hall or a library.

» Coordinate efforts with home builders and developers for the construction of Zero Energy Homes.

» Coordinate with the Air District with respect to air emissions to develop a standard procedure for the all major manufactured distributed generation products currently listed on the U.S. Department of Energy web site for distributed generation.

» Undertake a review with the utility serving the community to identify points on the grid where overload or growth is forecast so as to reduce the need for new and expensive transmission and distribution upgrades.

» Undertake an evaluation with the utility where the distributed generation locations would provide Demand Response benefits as currently called for in the State's Energy Action Plan.

» Undertake a California Environmental Quality Act review for the cumulative impacts of multiple distributed generation (project level) towards the aim of proving significant system benefits and jump-starting the industry to reduce per unit costs.

» Work with other neighboring local governments in a regional effort to enact a consistent set of DG zoning and permitting requirements so that applicants can take advantage of standardization.

» For solar distributed generation (photovoltaic panels), develop a recommendation for special handling including expedited review, waiving of permit fees, reduction of business/sales tax on materials.

» Provide an annual report on the activities underway under the distributed generation policy including amount of clean electric provide locally, reduction in carbon dioxide emissions, and net economic impacts.

» Convert any conventionally heated public swimming pools to solar water heating when any major renovations occur, and/or when funding allows. The investor-owned utilities can provide financial assistance to switch to solar water heating.

Energy Savings

Distributed generation can be used on-site or within the local area served by a distribution feeder or substation. Placing generation close to load will reduce the amount of energy purchased from a utility and avoid transmission and distribution losses. To be most effective, the facilities consuming on-site generation should be made as energy efficient as possible, reducing the size of heating, ventilation, and air conditioning equipment, and potentially the size of the distributed generation system.

Combined heat and power systems can significantly reduce energy use, criteria pollutants, and carbon emissions through their improved efficiency of fuel use. Integrated systems for combined heat and power can increase the efficiency of energy utilization to as much as 85 percent (compared to about 35 percent for conventional systems) and save about 40 percent of the input energy required by conventional systems.[3]

Environmental Benefits

Distributed generation from renewable resources, such as solar photovoltaic, solar thermal wind, dairy digesters, gas from wastewater treatment, and landfill gas, will offset the amount of energy generated from fossil fuels, thereby reducing greenhouse gas and pollutant emissions. The net impact of other types of distributed generation will depend upon emissions from the local power source as compared to grid-average emissions associated with electricity generation. By increasing the efficiency of energy utilization, integrated systems for combined heat and power will decrease the amount of fossil fuel consumed per unit of energy used and can lead to a 45 percent reduction in air emissions, compared to conventional centralized power plants using the same fuel source.[4]

On a national scale, if all wastewater treatment facilities that operate anaerobic digesters and have influent flow rates greater than five million gallons per day were to install combined heat and power, approximately 340 megawatts of clean electricity could be generated, offsetting 2.3 million metric tons of carbon dioxide emissions annually. These emission reductions are equivalent to removing approximately 430,000 cars from the road.[5]

Economics

The cost of electricity produced by a DER technology can be estimated and compared to the price currently being paid for electricity from the power grid. Equipment costs for DER technologies are often quoted in terms of their cost per kilowatt of electricity produced, or $/kilowatt (kW). For example, a 50 kW microturbine may cost $1,000/kW, or $50,000. Combining some technologies, such as solar photovoltaic panels, with more cost effective energy efficiency will greatly reduce the payback period.

The cost of electricity to facilities is generally based on power demand (measured in kW) and electric energy usage (measured in kWh). The power demand charge is generally a monthly charge ($/kW) based on the maximum power used during a month for a specified period, generally 15 minutes to 30 minutes. Combined heat and power systems reduce power demand in two ways: 1) by generating some of the power at site; and 2) by using thermal energy from power generation equipment, instead of electricity, for operating cooling, heating, and/or humidity control equipment.[6] Even though the initial cost of these systems is higher than purchasing all electric power needs and using conventional chillers and boilers for cooling, humidity control and heating needs, their life-cycle cost is often lower because of the energy cost savings over their useful life of more than 20 years.[7]

Programs In Operation

The Santa Rita Jail is the largest consumer of energy of all the **Alameda County** government buildings. To reduce energy expenditures, in the spring of 2002 the County completed the largest rooftop solar system in the nation at the time at this facility, which produces 1.18 MW of power under peak sunlight conditions. The first year savings was $425,000, and the lifetime (25 year) savings is expected to be over $15 million.[8]

Pasadena City College worked with Pasadena Water and Power to reduce energy costs by generating some of its own power, as well as utilizing combined heat and power to heat a 750,000-gallon swimming pool that is maintained at 81°F. To heat the pool, two Capstone 60 kW microturbines with heat recovery were installed, using the same amount of gas as previously used to heat the pool while at the same time generating an extra 120 kW of power. As a result, the college is saving about $100,000 per year in electricity costs, which were realized with a four-month payback.[9]

The Atrium Hotel at **Orange County Airport** installed three 60-kW Capstone microturbines with integrated heat recovery. The turbines were intended to save energy costs associated with the natural gas used for heating water and providing heat to the rooms, while generating electricity for the hotel. The hotel has realized $139,000 in annual savings (both natural gas and electricity). While

Santa Rita Jail with cool roof and PV system.

the total capital cost of the turbines was about $338,000, the hotel received a rebate of about $101,000, resulting in a net capital expense of $236,000, and a payback of less than two years.[10]

In August 2001, fifty 30-kW Capstone microturbines were installed at the **Lopez Canyon Landfill** in Lake View Terrace, California as part of the Green Power for a Green L.A. Program. The microturbines were funded through a Los Angeles Department of Water and Power (LADWP) commitment to the Southern California Air Quality Management District (SCAQMD) to spend $14 million on clean air projects. The microturbines operate on landfill gas that would otherwise be flared into the atmosphere. This project has eliminated approximately 10,000 pounds of nitrogen oxide emissions per year – the equivalent of removing 500 cars from Southern California roads. Combined, the fifty microturbine units generate a total of 1.5 megawatts of electricity, enough to power an estimated 1,500 homes in the Los Angeles area.[11]

In 2004, the **Los Angeles County Sanitation District** (LACSD) began operating a 250 kW fuel cell combined heat and power system at the Palmdale Water Reclamation Plant. Seventy to eighty percent of the digester gas produced by the facility is utilized by the fuel cell. The system produces 225 kW of electricity for use on site, while waste heat from the fuel cell exhaust is used to maintain proper temperature for digester operation. The combined heat and power system reduces annual carbon dioxde and nitrogen oxide emissions by 778 tons and 0.58 tons, respectively, and saves LACSD approximately $227,000 per year in energy costs.[12]

RESOURCES

The California Distributed Energy Resources Guide contains a wealth of information regarding distributed energy resources. http://www.energy.ca.gov/distgen/index.html.

The California Energy Commission released a report in December 2000 titled Distributed Generation: CEQA Review and Permit Streamlining. This report describes the permitting processes conducted by city and county governments and air districts for small-scale electric generating facilities. For the complete report, see h ttp://www.energy.ca.gov/distgen/documents, Report No. 700-00-019.

The Energy Commission has mapped the potential for solar and wind energy throughout the state. The maps are available at:

» http://www.energy.ca.gov/maps/wind.html

» http://www.energy.ca.gov/maps/solar_potential.html

Related Strategies

B.1.3 Solar Energy
C.1.1 Community Energy Authorities

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LOCAL FOOD

A great deal of energy is used in the production and transport of food. Produce in the United States travels, on average, 1,300-2,000 miles from farm to consumer, and since the 1970s, has increasingly been moved by truck, which is less energy efficient than other modes of transport.[1] The energy used to move food in California may be less because so much food is grown in the state.[2] A study by the American Farmland Trust found that 20 million tons of food is produced annually within 100 miles of San Francisco, where less than one million tons is consumed in a year. However, the energy associated with food production and transport remains very significant.

In general, the farther food travels and the longer it takes to get to a consumer, the more fossil fuels will be required for transport, and the less fresh it will be. Growing food locally will not always result in net energy savings, however. Growing some foods in unsuitable climates may use more energy than growing and shipping them from somewhere more appropriate. For example, it is more energy-efficient for Swedes to import tomatoes from Spain than it is for them to grow tomatoes themselves, since the latter requires heated greenhouses.[3]

Lake Merritt Community Garden in Oakland.

This section provides ideas for how local governments can promote consumption of locally-grown food.

General Plan Language Ideas

- The City/County shall work to preserve regional agriculture and farmland as a source of healthy, local fruits and vegetables and other foods, and connect local food markets to local agriculture.
- The City/County shall encourage, support and find sites for farmers markets and community gardens as important open space resources that build community and provide local food sources.

Implementation Ideas

Local government can provide a variety of opportunities for community gardens and urban farms.

- **Encourage the use of vacant lots for community gardens**, for example, by allowing community gardens as a use in all zones, creating a specific "community garden" zoning regulation, protecting gardens from confiscation, and providing free water/trash collection. A community garden provides green space in urban areas and encourages food production by providing gardeners a place to grow vegetables, fruits, and flowers. Community gardens strengthen communities, build social capital, and instill pride. Some community gardens have even become a source of income in which the produce grown from the garden is then sold in local farmer's markets.

» **Support the use of city streets and parking lots space by farmers markets and pickup/dropoff sites** for Community Supported Agriculture. Community supported agriculture allows consumers to pay growers for a share of farm produce, and growers provide the consumers with a weekly share of food. Members on average would pay about one-third more for the same food at a supermarket.[4]

» **Identify and inventory potential community garden/urban farm sites** on existing parks, public easements, rights-of-way, and schoolyards, and prioritize site use as community gardens in appropriate locations.

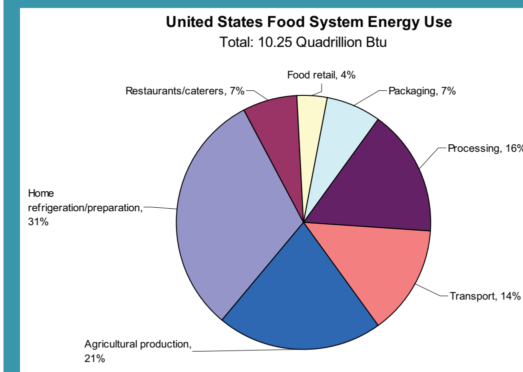
- Convert neglected areas into green spaces that can be used for community gardens or provide community garden grants and support. This can be done by issuing bonds to nonprofits to transform vacant lots, providing city resources to nonprofit groups who run community gardens, reducing or waiving plot fees or locating the gardens within walking distance of lower-income neighborhoods, or starting an initiative to redevelop and clean up vacant land.

» **Consider setting a community garden standard** (e.g., at least one community garden for every 2,500 households).

» **Offer residents classes such as gardening or composting,** or support a community-based organization to do so; prioritize classes in neighborhoods that lack access to healthy foods and/or green space. Connect local agencies such as waste management who may be willing to deliver compost for free or provide composting services.

Food and Energy Use

Food production and transport accounts for 17 percent of fossil fuel use in the United States. Of the energy used for the food production system, 20 percent is used for actual production, and 80 percent is used for processing, transportation, home refrigeration, and preparation (see below).



Source: Heller and Keoleian. 2000. Life Cycle-Based Sustainability Indicators for Assessment of the U.S. Food System. Ann Arbor: University of Michigan.

» **Protect agricultural land from urban development** except where the general plan land use map has designated the land for urban uses (establish green belts for agricultural buffers around urban land; require developers to place lands within this buffer into permanent agriculture land trust or other agricultural easements).

» **Support procurement of locally grown food.** Assess and plan for local food processing/wholesaling/distribution facilities to connect local agriculture to markets such as retailers, restaurants, schools, hospitals, and other institutions. Protect areas zoned for industrial use from being rezoned for other uses such as commercial or residential, so that local processing is not lost.

» **Support efforts to create a farms-to-schools program and school gardens.** A farms-to-schools program encourages schools to use locally grown produce for school meals, and supports local farmers and economies. School gardens reduce the need to transport food, and help to develop future home and community gardeners.

Energy Savings

The closer that food is consumed to where it is grown and processed, the less transportation fuel will be needed. A University of Montana study found that replacing a year's supply of conventionally sourced hamburgers and fries with local ingredients at campus sites saved 43,000 gallons of fuel and the associated GHG emissions.[5]

Environmental Benefits

A study in Iowa found that for delivery of 28 locally available fresh produce items, using a conventional national delivery system consumed four to 17 times more fuel than Iowa-based regional and local systems, depending on the system and truck type. The same conventional system released from five to 17 times more carbon dioxde from the burning of this fuel than the Iowa-based regional and local systems.[6]

Economics

In the 1950s, farmers in the United States received 45-60 percent of the money that consumers spent on food. Today, they receive just 3.5 percent.[7] When farmers sell directly, as at farmers' markets or through community based agriculture programs, they keep almost all the food dollars spent by consumers. This keeps the money in the local economy, as opposed to being spent on supermarket items that could come from anywhere in the world.

Kern County Department of Public Health Farmers Market.

The Central California Regional Obesity Prevention Program (CCROPP) is dedicated to creating healthier environments that support healthy eating and active living. CCROPP is committed to addressing childhood and adult obesity through place-based policy change that supports access to healthy, affordable foods and physical activity resources in the San Joaquin Valley. This unique, comprehensive approach is being carried out by partnerships between public health departments, community-based organizations, and community councils in Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties. The program was developed by the Central California Public Health Partnership and is administered through the Central California Center for Health and Human Services at California State University, Fresno. Funding for this initiative was made possible by The California Endowment and the Robert Wood Johnson Foundation.

The Central Valley grows an abundance of fruits and vegetables, however, many residents have limited access to the locally grown produce. In Kern County, this problem is compounded by high rates of obesity and associated illnesses such as diabetes and heart disease.

The Kern County Department of Public Health (KCDPH) knew that they needed to address the obesity epidemic. To compete with the high concentration of nearby fast food restaurants and convenience stores, the KCDPH partnered with the CCROPP to institute an on-site farmer's market in 2007. The market had a lsow start, but over time has grown not only for employees, but community residents, and recipients of the Women and Infant Children Farmer's Market Vouchers. The farmer's market was the first step for the both CCROPP and KCDPH to make an environmental change that would produce in healthier eating habits.

continued >>>

In addition to increasing residents' access to fresh produce, community gardens provide residents with environmental education, green space, and significant savings on their food. For example, community gardeners in Philadelphia reported an annual savings on food bills of $700 per family.[8]

Programs In Operation

The **Davis** Farm to School Connection embodies a systems approach to education by supporting programs within the local school district that connects classroom studies with hands-on experiences, such as garden based learning, classroom cooking, cafeteria taste-testing, local farm visits for second graders, and waste management programs such as composting and recycling. The community was the first in the nation to vote in a parcel tax renewal to fund farm fresh produce to improve school lunches. http://www.davisfarmtoschool.org.

Berkeley's General Plan establishes open space (including community gardens) as the highest priority for city-owned vacant land. Measure L, passed by Berkeley voters in 1986, requires a vote of the people to use or to develop a public open space or park for any purpose other than a public park or open space, unless a State of Emergency has been declared. http://www.ci.berkeley.ca.us/contentdisplay.aspx?id=494.

To create **Fresno's** Green Strategy, planning staff partnered with Fresno Metro Ministries and Central California Regional Obesity Prevention Program, along with other farmers' market stakeholders, to amend the zoning code to define farmers' markets and allow them in all commercial zones and even the most basic residential zone district R-1 (with a conditional use permit). Allowing farmers' markets in residential areas brings fresh food to where it is most needed. http://www.fresno.gov.

The **San Luis Obispo** Downtown Association is an advisory body to the City Council funded by sales tax proceeds from its district. In 1983, the Downtown Association decided to barricade six blocks of one street on Thursday nights so people could shop late and enjoy special activities and entertainment. http://www.downtownslo.com/farmers.html.

Portland, Oregon's zoning code allows community gardens in all residential areas. Park and Open Spaces are uses of land focusing on natural areas, large areas consisting mostly of vegetative landscaping or outdoor recreation, community gardens, or public squares (city of Portland, 33.920.460). With special limitations, community gardens are allowed within all residential, commercial, and open space zones of the city (city of Portland, 33.100.100, 33.110.100, 33.120.100, 33.130.100). http://www.portlandonline.com/auditor/index.cfm?c=28197

Seattle, Washington's P-Patch Program provides 68 gardens for residents throughout Seattle, and will be adding another four gardens in 2009. The community based program offers community gardening, market gardening, youth gardening, and community

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KCDPH has provided technical assistance to other agencies in initiating their own farmer's markets, and helped the city of Delano incorporate zoning language supportive of farmer's markets into its general plan.

The KCDPH has included language on operating an annual farmers market in their worksite wellness policy and has plans to operate more markets in other low-income communities. The intangible idea of changing the environment has grown to several tangible markets with the outcome of providing an access to healthy produce to those in need.

Avtar Nijjer-Sidhu is the Community Health Capacity Building Specialist for the Kern County Department of Public Health. Avtar works at building the internal capacity of the public health department to respond to the obesity epidemic through CCROPP. In addition, Avtar works in partnership with Get Moving Kern, a local CCROPP community partner, at improving local environments for healthy eating and active living.

food security. These programs serve all citizens of Seattle with an emphasis on low-income and immigrant populations and youth. The community gardens serve more than 3,800 urban gardeners on 23 acres of land. http://www.seattle.gov/Neighborhoods/ppatch

New York City has established a mobile markets initiative that has put "green carts" full of fresh fruits and vegetables in lower-income areas that have the least access to fresh produce and where residents report the lowest consumption of fruits and vegetables. New York City partnered with a nonprofit small business lender to provide low-interest loans to green-cart vendors. The loans cover start-up costs, such as equipment and inventory. In a related measure, the city's health department launched a Healthy Bodegas Initiative, whereby the city helps neighborhood bodega owners promote the offering of low-fat milk and fresh produce in communities that have the highest rates of poverty and diet-related diseases in the city. http://council.nyc.gov/html/releases/011_022708_prestated_greencarts.shtml

Resources

The **National Sustainable Agriculture Information Service** web site is sponsored by the National Center for Appropriate Technology and funded by a grant from the U.S. Department of Agriculture's Rural Business-Cooperative Service. It provides information and other technical assistance to farmers, ranchers, Extension agents, educators, and others involved in sustainable agriculture in the United States. *Bringing Local Foods to Local Institutions: A Resource Guide for Farm-to-School and Farm-to-Institution Programs* is one of its programs. http://attra.ncat.org.

The **Local Harvest** web site provides information on farmers' markets, family farms, and other sources of sustainably grown food throughout the United States where produce, grass-fed meats, and many other food items can be purchased. http://www.localharvest.org

Planning for Healthy Places (PHP), a program of Public Health Law & Policy, works to engage public health advocates in the planning decision-making process throughout California. PHP develops tools for training advocates in the relationship between the built environment and public health, and provides technical assistance for creating and implementing land use policies that support healthier communities. It is developing model general plan language to protect community gardens. Many of the implementation ideas above come from the Healthy Places publication: *How to Create and Implement Healthy General Plans: A toolkit for building healthy, vibrant communities through land use policy change*. http://www.healthyplanning.org.

Ecotrust is working on a wide-range of initiatives to promote "farm to school" programs that enable schools to feature healthy, locally sourced products in their cafeterias, incorporate nutrition-based curriculum in all academic disciplines, and provide students with experiential agriculture and food-based learning opportunities, from farm visits to gardening, cooking, composting, and recycling. http://www.ecotrust.org/farmtoschool

The **Farm-to-School Program** web site provides resources broken down by state. It includes guides, reports and strategies. The site also includes state and local policy recommendations aimed at fixing the current school meal programs to incorporate fruits and vegetables from local farms. http://www.farmtoschool.org

The **FoodRoutes Network** is a nonprofit organization that provides information about promoting community-based food systems. http://www.foodroutes.org

The **U.S. Department of Agriculture's** *Farmers Market Promotion Program Guidelines* help entities seeking funding from the USDA Farmers' Market Promotion Program. Eligible entities include local governments, nonprofit corporations, agricultural cooperatives, and other domestically-located entities whose main source of income results from producing and selling produce directly to consumers. http://www.ams.usda.gov

The **Local Government Commission** has developed the *Cultivating Community Gardens: The Role of Local Government in Creating, Healthy, Livable Neighborhoods* fact sheet. http://www.lgc.org

The **Wallace Center** offers information on "Getting Started with Farmers' Markets" and "Recruiting Vendors for a Farmers' Markets." http://www.wallacecenter.org and http://www.farmersmarketsusa.org

Related Strategies

C.1.1 Community Energy Authorities

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SOLID WASTE

Energy is used to manufacture products and to collect and transport solid waste. Policies that reduce waste, increase reuse and increase recycling will save energy.

Waste reduction (or prevention) is the preferred approach to waste management because it saves the cost and energy associated with collecting, separating and transporting waste material and integrating the recycled materials back into the manufacturing process.

Reusing products and materials in their original form can save more energy than recycling because energy is not used to transform the materials into new products. Many materials that would otherwise be thrown away can be reused with little cleaning or repair. Materials such as appliances, furniture, bags, boxes and other containers, building materials (doors, windows, bricks, etc.) scratch paper, clothing and wood pallets can often easily be reused.

Recycling used materials by transforming them into new products also can save energy. For example, making new aluminum cans from used cans requires 95 percent less energy than producing cans using virgin ore.[1]

Most of the focus of recycling programs implemented by California jurisdictions over the last two decades has been on the residential sector, although commercial businesses in California generate more than half of all solid waste.[3]

California's Integrated Waste Management Act

In 1989, the state legislature passed the California Integrated Waste Management Act, AB 939, requiring each jurisdiction to divert 25 percent of waste by 1995 and 50 percent by 2000.

Eighty-five percent of California's local governments have met the 50 percent diversion requirement; most of the others have made a good faith effort to do so.

As of the end of 2008, California diverted 54 million tons of the 93 million tons of solid municipal wastes it generates yearly, an amount equal to 58 percent. In 1990, California diverted just 10 percent of its garbage (Source: California Integrated Waste Management Board).

Reuse Area at the Sonoma County Central Disposal Site.

General Plan Language Ideas

» It shall be the policy of the City/County to purchase products that: 1) are made from recycled materials; 2) can be recycled; and/or 3) have a minimum amount of packaging. By [date] the Council/Board shall adopt an ordinance establishing specific procurement standards and preferences for products that are recycled, recyclable, and have minimal packaging. Additional preference will be given to products produced locally.

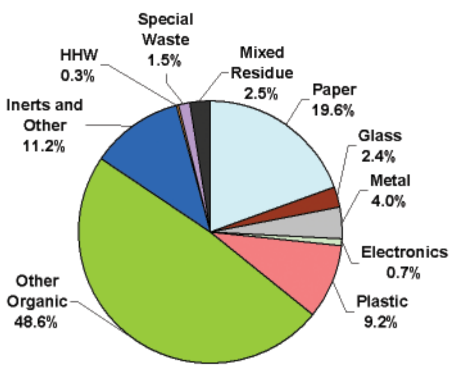

Figure 1. Material Classes in California's Residential Disposed Waste Stream, 2008

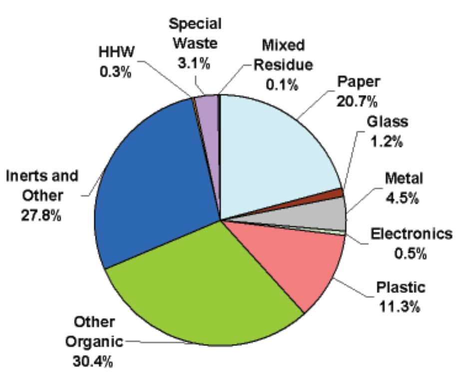

Figure 2. Material Classes in California's Commercial Disposed Waste Stream, 2008
Source: California 2008 Statewide Waste Characterization Study. [2]

» The City/County shall provide education and incentive programs to encourage xeriscaping, backyard composting and mulching.

» To provide an incentive to reduce and recycle and to reward residents who already actively reduce and recycle, residential garbage collection fees will be based upon the amount of garbage collected rather than a flat fee.

» The City/County shall establish a mandatory commercial recycling ordinance, a construction and demolition ordinance, and a space ordinance requring new developments to secure enough space for recycling receptacles on their property.

» The City/County shall facilitate the establishment and retention of reuse and recycling businesses by providing appropriate zoning, technical assistance, and incentives. This includes businesses that 1) use post-consumer materials to manufacture products, 2) process recyclable materials for use by other businesses, and 3) sell used and refurbished items. If not already in a Recycling Market Development Zone, consider working with the California Integrated Waste Management Board to establish one.

» The Economic Development and Solid Waste Management departments shall coordinate activities to locate new and retain existing reuse and recycling businesses in the community.

Implementation Ideas

» **Adopt a procurement policy or ordinance.** Local governments can adopt policies (administratively or through ordinance) that give price preferences to products that are recycled, recyclable, or made with minimal packaging. They can also require a percentage of government product purchases (e.g. paper) to meet these requirements. Purchasing costs may be reduced by buying in bulk with neighboring jurisdictions. Purchasing specifications can be reviewed and modified to ensure they do not inadvertently discriminate against recycled products. Municipal "buy recycled" programs can be publicized to local businesses.

» **Start a backyard composting education program.** An education program can include workshops, printed brochures and pamphlets, individualized instruction, demonstration compost sites (combined with low-water demonstration gardens), presentations to community groups, displays at community events, public buildings and garden supply stores, information hotlines, newspaper features, utility bill inserts and school programs. The University of California Cooperative Extension Service, Conservation Corps, college and university academic departments (e.g. horticulture, landscape architecture), garden clubs and other interested groups can help set up a program, and volunteers can help staff program.

» **Provide residents with free or discounted composting bins and tools.** Bins come in a variety of types and materials, including open air wood bins, wood frames with wire mesh, plastic open and closed air bins and rotating drums.

Compost bins.
Photo: San Mateo County.

High Tech Trash

Electronics are a fast growing portion of America's trash - 250 million computers are destined to become obsolete by 2005. Researchers estimate that 75 percent of old electronics are in storage. (Source: Environmental Protection Agency).

In California, more than 500 million pounds of televisions and computer monitors have been recycled since 2003. (Source: California Integrated Waste Management Board)

» **Promote composting and mulching to commercial gardeners and landowners.** While on-site composting may not be possible at many commercial sites, mulching can be practiced nearly anywhere to retain moisture, suppress weeds and protect plants from extreme temperature changes. Locally composted materials and mulch have less embodied energy than materials that are transported long distances. Some non-residential sites, such as golf courses, college and university campuses and cemeteries, might be able to compost on-site.

» **Investigate a commercial recycling ordinance.** The investigation shall determine the amount and types of materials that could be diverted. Recommended thresholds for participation (e.g., all commercial and multifamily operations, commercial entities with ___ number of employees, generate ___cubic yards per week or more of solid waste, multifamily entities of ___units or more) will be based on maximizing diversion at minimal expense.

» **Adopt a construction and demolition (C & D) recycling/reuse ordinance.** Waste from new construction sites and demolition projects can create significant waste. Materials often can be recycled or reused, such as windows, doors, lights, plumbing fixtures, sinks, tubs, toilets, and concrete. C & D materials can stimulate local reuse businesses such as Urban Ore in Berkeley, and Habitat for Humanity stores throughout the United States.

» **Compost and mulch green wastes from city/ county landscaping.** Provide a model for residents and businesses. Composting sites can be located in parks and public golf courses.

» **Establish variable garbage can rates.** Offer residents the option to use a smaller garbage container for a reduce fee, or charge residents per can.

» **Encourage and facilitate new reuse and recycling businesses.** Host workshops for potential entrepreneurs about how to start a new reuse and recycling business in the city. Provide support in the form of contacts, grant application assistance, financial support (e.g. tax incentives, low-interest loans, bond financing, redevelopment funds, reduced business license fees, Community Development Block Grants or loans), and supportive infrastructure expansion. If the city/ county is not already in a Recycling Market Development Zone, consider working with the Integrated Waste Management Board to establish one (see Resources).

» **Use zoning to encourage new recycling businesses.** Revise the zoning code to allow recycling businesses, particularly in new or existing redevelopment areas and industrial parks. Allow reuse and rental shops (a form of reuse) in shopping centers and other prominent locations. Provide streamlined processing and eliminate or reduce application and development fees for reuse and recycling businesses.

» **Support existing recycling businesses.** Maintain and/or expand existing reuse and recycling businesses and retool manufacturing operations for recycled feedstocks. Make sure that new local codes or requirements do not pose problems to reuse and recycling businesses. Include reuse businesses in city/county programs to collect bulk wastes, such as spring cleanup days.

» **Provide recycled materials to local reuse and recycling businesses.** Require that materials collected through residential curbside recycling programs and other city/county recycling programs be offered to local recycling processors and industries first. Establish a local material exchange program or become a partner with CalMAX and promote it on the municipal web page. See the Resources section below for a link to the CalMAX program.

» **Cooperate regionally.** Work with neighboring governments to attract and maintain businesses that need large amounts of recycled materials. Institute regional agreements to guarantee a steady and large supply of recycled feedstock for local manufacturers.

Energy Savings

If less wate is generated, less waste is used in the manufacturing and transport or wasted materials. Recycling can also save energy because in some cases it takes less energy to recycle new materials than it does to obtain new materials. For example, less energy is required to produce a gallon of re-refined oil than creating new oil.

Reducing the amount of garbage collected at residences can reduce the energy used to transport garbage if garbage routes can be consolidated. This means fewer trips to the landfill or transfer site. Fuel savings may be partially offset by an increased need for curbside pickup of recyclables.

Backyard composting reduces transportation energy needs if garbage routes can be consolidated, requiring fewer trips to the dump. Almost half of residential waste is organic, most of which can be composted. If one-third of households compost one half of that waste, eight percent of household waste will be diverted from the local landfill. With this reduction, one out of every 13 trips to the landfill can be eliminated.[4]

Environmental Benefits

The California Center for Sustainable Energy (CCSE) operates programs in the San Diego area. From 2004 through

2008, CCSE has sequestered or reduced 28,010 metric tons of CO_2e (equivalent to 79 million kWh of electricity) with the Cool Communities Shade Tree Program, the California Solar Initiative, the Solar Water Heating Program, and a group of energy efficiency programs. CCSE also operates the Self-Generation Incentive Program (SGIP) in San Diego Gas and Electric's service territory (SGIP carbon savings are not included in the number above because the program's benefits are still being assessed).[8]

Economics

Increasing demand for recycled products can translate into increased local manufacturing, business startups and business expansion. Local governments "close the loop" by using community waste to serve community needs. The energy used to transport commodities to markets in other states or countries is saved.

California has created an industry of 5,300 businesses connected to recycling. Recycling now accounts for 85,000 jobs, generates $4 billion in salaries and wages and produces $10 billion worth of goods and services annually.[9] Recycled Market Development Zones have helped businesses divert 7 million tons of solid waste and created 8,800 jobs.[10]

If garbage collection fees are based on the volume or weight of garbage disposed, rather than a flat fee, residents are given an economic incentive to reduce and recycle waste.

Programs In Operation

Local governments in California have been operating and/or participating in solid waste diversion programs for many years. In 2006, 331 jurisdictions had achieved 50 percent waste diversion or greater.

Resources

The **California Integrated Waste Management Board** (CIWMB) has many resources to help local governments, residents and businesses to reduce solid waste. Some include:

» CIWMB Home Page: http://www.ciwmb.ca.gov

» Local Government Central: http://www.ciwmb.ca.gov/LGCentral

» CalMAX (material exchange): http://www.ciwmb.ca.gov/CalMAX

» Buy Recycled program: http://www.ciwmb.ca.gov/BuyRecycled

The CIWMB's **Recycling Market Development Zone** (RMDZ) program combines recycling with economic development to fuel new businesses, expand existing ones, create jobs, and divert waste from landfills. This program provides attractive loans, technical assistance, and free product marketing to businesses that use materials from the waste stream to manufacture their products and are located in a zone. The zones cover roughly 71,790 square miles of California from the Oregon border to San Diego. Assistance is provided by local zone administrators and the CIWMB's Referral Team (R-Team). Local government incentives may include relaxed building codes and zoning laws, streamlined local permit processes, reduced taxes and licensing, and increased and consistent secondary material feedstock supply. http://www.ciwmb.ca.gov/rmdz

The **California Department of Conservation** is the other state agency focused on recycling. It hosts the environmentally preferred procurement web site. http://www.green.ca.gov/EPP/Introduction/default.htm.

The **United States Environmental Protection Agency** has many resources to encourage waste reduction. http://www.epa.gov/epawaste/nonhaz/municipal/index.htm

Californians Against Waste is dedicated to conserving resources, preventing pollution and protecting California's environment through the development, promotion and implementation of waste reduction and recycling policies and programs. http://www.cawrecycles.org

Alameda County's StopWaste.org has numerous programs, guides and information for residents, businesses and local governments in the Bay Area on all kinds of recycling and waste prevention programs. Model ordinances and general plan language area also available. http://www.stopwaste.org.

The **Electronics Industries Alliance**, in cooperation with contributing manufacturers Canon, HP, JVC, Kodak, Nokia,

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Panasonic, Philips Electronics, Sharp, Sony, and Thomson, has initiated an innovative electronics collection and recycling pilot project. Check with other manufacturers directly to see if they have programs. http://www.eiae.org/index.php

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MUNICIPAL PROCUREMENT

Local governments have many opportunities to affect the amount of energy they consume through their procurement choices, whether it be purchasing re-used, recycled, or sustainably sourced products; buying electricity from renewable resources; or procuring vehicles for municipal fleets (see C.5.3 Municipal Fleet Efficiency). The benefits of these strategies are covered elsewhere in this guide. This chapter focuses on the mechanics of procurement.

General Plan Language Ideas

» The City/County shall adopt an environmentally preferred procurement policy in order to:

- Conserve natural resources.
- Minimize environmental impacts such as pollution and overuse of water and energy.
- Eliminate or reduce toxics that create hazards to workers and the community.
- Support strong recycling markets.
- Reduce the amount of material going to landfills.
- Increase the use and availability of environmentally preferable products that protect the environment.

The Cost of Sustainable Procurement

Purchasing re-used, recycled, and energy efficient products may be harder to justify if up-front costs are higher than those for conventional products. This disparity may be lessened or eliminated, however, when the costs of operation and disposal over the period of ownership are taken into account. This accounting technique is referred to as "ownership costing." Higher costs may also be attenuated by aggregating purchases with other communities, through buying cooperatives or through the California Multiple Awards Schedule (CMAS) program (see the Resources section for more information).

Several avenues are available to reduce the cost of renewable energy, including direct rebates from the California Solar Initiative (CSI) program and Federal tax credits. While local governments cannot take advantage of tax credits, through power purchase agreements (PPA) a city or county can host and agree to purchase the electricity from a renewable system that is owned by a private entity that is able to take the tax credits.

- Identify environmentally preferable products and distribution systems.

- Reward manufacturers and vendors that reduce environmental impacts in their production and distribution systems or services.

» The City/County shall develop and abide by an environmentally and socially responsible procurement policy that emphasizes long-term values and will become a model for other public as well as private organizations. The adopted procurement policy will be applicable to City/County programs and services in all areas.

» The City/County shall investigate ways to keep the cost of environmentally and socially responsible procurement economically feasible including, but not limited to, use of ownership costing, aggregated purchasing, and participation in the CMAS program.

Implementation Ideas

» **Conduct a pilot study of environmentally preferable purchasing** by developing environmental selection criteria for products used to maintain city/county buildings and vehicle fleets. The pilot program should demonstrate whether products meeting these criteria are available, cost competitive, and effective at meeting the city/county's performance standards. If the pilot program is deemed successful, adopt an environmentally preferable purchasing program for the city/county.

» Decide when a recycled product can perform the function as well as a product from only virgin materials and the cost reasonably approximates the cost of the product from virgin materials. Adopt a policy that products should be purchased which contain, in order of preference:

- The highest percentage of post-consumer recovered material available in the marketplace.

StopWaste.Org has developed a resource guide for environmentally preferred products that contains over 100 items (see the Resources section for more information). Some typical products that local governments purchase that have sustainable options include:

» Computers
» Copy paper
» Writing tablets
» Envelopes
» File folders
» Card stock
» Self stick notes
» Newsprint
» Paper towels
» Toilet tissue
» Facial tissue
» Paper napkins
» Corrugated boxes
» Padded mailers
» Printer cartridges
» Printer ribbons
» Compact discs (rewritable)
» Plastic or cardboard binders
» Pens and pencils
» Batteries
» Energy star electronics
» Cleaners
» Trash bags
» Food service plates, cups, flatware
» Coffee filters
» Office furniture
» Carpeting
» Park benches

- The highest percentage of pre-consumer recovered material available in the marketplace.

- Paper products that at a minimum meet the state of California's definition of "recycled paper products."

» Incorporate energy and water expenses into purchasing decisions. While inefficient equipment may be less expensive to purchase initially, the utility costs over the lifetime of the item may be significantly higher. Lifecycle costing incorporates this information into the procurement process (see C.5.2 Municipal Facilities). A "green audit" of all municipal purchases could be conducted to identify environmentally preferable alternatives.

» Establish a bidding preference to local businesses for city/county contracts. Purchasing goods and services locally contributes to sustainable economic development by reducing environmental impacts related to transportation, employs local residents, and redistributes city/county funds back into the community.

» Develop green building guidelines to help reduce negative environmental impacts from construction and development in the city/county. The guidelines should include required and recommended practices to reduce life-cycle environmental impacts from the construction and operation of both commercial and municipal developments and major remodel projects. These guidelines should provide specific green design and construction strategies and specifically address the purchase of building materials, electrical equipment, plumbing fixtures, and landscaping materials.

Energy Savings

Procurement programs that specify recycled content, renewable energy or energy efficient products will reduce the amount of energy consumed by the city or county. See strategies C.2.1 Renewable Energy Resources and C.4.1 Solid Waste for details.

Environmental Benefits

In June 1999, the City of Santa Monica entered into a contract with Commonwealth Energy Corporation for the purchase of 100 percent renewable energy to power all city facilities. Santa Monica was the first municipality in the United States to obtain all of its electricity from renewable sources. A projection based on the city's 1998 energy use data indicated the switch to 100 percent renewable electricity will annually reduce GHG emissions by 13,672 tons, nitrous oxide (NOx) emissions by 16.2 tons, sulfur oxide (SOx) emissions by 14.57 tons, particulate matter (PM_{10}) by 2,285 lbs. and reactive organic groups by 190.5 lbs.[1]

One metric ton of carbon dioxide equivalent is eliminated when replacing a product made from virgin material with any of these choices:

» 20 cases of 30 percent post consumer content copy paper.

» 6 cases of 100 percent post consumer content copy paper.

» 15 recycled plastic park benches with backs made with 98 percent post consumer content.

» 900 pounds of 100 percent post consumer content recycle rubber.[2]

Economics

Santa Monica contracted for 100 percent renewable energy during the period when "direct access" was allowed by California's restructuring of the electric industry. As a result, the city's electricity rates following the market upheavals in 2000 and 2001 were lower than the rates they would have been paying had they stayed with Southern California Edison. The rate comparison in subsequent years has varied.[3]

Certain products may have a higher initial purchase cost, but may require less maintenance or long-term costs over their lifespan. That's why it is important to consider short-term and long-term costs when comparing product alternatives, when feasible. This includes evaluating the total costs expected during the time a product is owned, including, but not limited to, acquisition, extended warranties, operation, supplies, maintenance, disposal costs and expected lifetime compared to other alternatives. Often when these 'ownership' costs are considered, the least expensively price product is not the most economical in the long run.

Programs In Operation

In 1994, the City of **Santa Monica** adopted its environmentally and socially responsible procurement program as one of the eight Guiding Principles of its Sustainable City Program. The city's procurement plan considers such issues as recycled content in purchased materials, toxic use reduction, fleet maintenance, tropical rainforest wood, ozone depleting chemicals, energy efficient office equipment, print shop inks, renewable energy for city facilities, green building guidelines, and a preference for accepting bids from local business. Santa Monica released its Green Office Buying Guide web site in 2009. It is an interactive green purchasing site, and a good resource for municipalities. http://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Buying_Green/Sustainable_Procurement_policies.pdf

The Green Office Buying Guide can be found at http://www.sustainablesm.com/buygreen.

San Francisco has adopted an environmentally preferable purchasing ordinance to reduce negative impacts to human health and the environment. San Francisco's specifications for purchases:

» Reduce exposure to potentially toxic chemicals for city staff, residents and visitors by purchasing products for use in city operations that do not harm human health or the environment.

» Reduce San Francisco's contribution to global climate change by purchasing products reduce greenhouse gas emissions from commodities.

» Improve San Francisco air quality by purchasing vehicles and motorized equipment that minimize emissions of air pollutants.

» Protect the quality of San Francisco's ground and surface waters by eliminating the use of chemicals known to contaminate local water resources.

» Preserve resources locally and globally through purchasing practices that include:

- Maximizing water and energy efficiency and favoring renewable energy sources.
- Maximizing post consumer recycled content and readily recyclable or compostable materials.
- Favoring long-term use by evaluating a product's durability, repairability, and ability to be recycled.
- Considering life cycle economics of a product that includes manufacture, transportation, use and disposal.

Are All Recycled Content Products Created Equal?

Pre-consumer versus Post-consumer Recycled Content

Many products are made from recycled materials. Items that use materials that have gone through their life cycles as consumer products and then are collected and used to make new products are called post-consumer materials. Preconsumer materials are generated by manufacturers and processors, and may consist of scraps, trimmings and other by-products that have never been used by consumers. Products usually list the percentage of recycled materials, and may include both pre- and post-consumer content.

Ventura County adopted a green procurement policy for County agencies that includes a 10 percent premium for qualified recycled paper products, and the use of life cycle cost analysis that considers final, disposal and replacement costs when feasible and appropriate. http://portal.countyofventura.org

Sacramento County's Public Works Agency adopted an environmentally preferred purchasing policy consistent with AB 939, which requires a 50 percent reduction of material going to landfills, and with the economics of effectively managing costs for solid waste disposal. This policy:

» Encourages waste prevention, recycling, market development and the use of recycled or recyclable materials through lease agreements, contractual relationships and purchasing practices with vendors, contractors, businesses and other governmental agencies.

» Establishes waste prevention, recycling and the use of recycled supplies and materials as an Agency priority.

» Generates less waste material by reviewing how supplies, materials and equipment are manufactured, purchased, packaged, delivered, used, and disposed.

» Serves as a model for others in the Sacramento region to prevent waste, encourage recycling and develop wise procurement policies.

http://www.ciwmb.ca.gov/Buyrecycled/Policies/SacCounty.htm

Resources

These organizations already have developed advanced, sustainable procurement procedures. They share their expertise on their Internet sites.

Alameda County's StopWaste.Org web page offers resources for developing and implementing an environmentally preferred procurement policy. This site includes a model policy, implementation guidelines, resource guides for environmentally preferred products, a guide to green maintenance and operations, and metrics for greenhouse gas savings. http://www.stopwaste.org

ABAG Publicly Owned Energy Resources (ABAG POWER) is a separate joint powers agency whose primary goal is to conduct pooled purchasing of natural gas on behalf of local governments and special districts that voluntarily join the Pool. Pooled purchasing enables local governments to achieve more competitive pricing from suppliers who are interested in larger and more attractive combined loads. The Pool is currently purchasing natural gas for 39 local governments and special districts in the Bay Area. http://www.abag.ca.gov/services/power

California's Department of General Services, California Multiple Awards Schedule (CMAS) offers a wide variety of commodities, non-IT services, and information technology products and services at prices which have been assessed to be fair, reasonable, and competitive. Suppliers may apply for a CMAS contract anytime, and no bids are required. The use of these contracts is optional and is available to both California State and Local Government agencies. http://www.pd.dgs.ca.gov/cmas/default.htm

Through its Buy Recycled program, the **California Integrated Waste Management Board** promotes the State's policy to "buy green." To assist potential grant applicants, as well as any local governments or businesses that consider creating a procurement policy, the Buy Recycled program compiles actual and proposed environmentally preferred procurement policies as a resource. http://www.ciwmb.ca.gov/Buyrecycled/Policies

The **Solana Center of Encinitas,** with funding support from U.S. EPA Region 9, provides recycled paper procurement to the public and private sectors through the Recycle Products Cooperative (RPC). To increase the use of recycled paper, the cooperative provides 30 percent post-consumer recycled paper that meets or beats the price that many businesses and public agencies pay for virgin fiber paper. There is no cost to be a member of the cooperative. Interested parties contact the Solana Center to receive pricing information and a customer number, which guarantees the co-op's discount pricing schedule. The paper available is tested and recommended by the U.S. Government Printing Office. http://www.recycledproducts.org

Related Strategies

C.1.1	Community Energy Authorities
C.2.1	Renewable Energy Resources
C.4.1	Solid Waste
C.5.3	Municipal Fleet Efficiency

Endnotes

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MUNICIPAL FACILITIES

The potential for saving money through energy and water fficiency in municipal facilities is tremendous, but requires commitment and organization. Lighting retrofits, HVAC replacements, and drought tolerant landscaping are just a few of the ways local governments can reduce their energy and water use. Developing a comprehensive plan and providing staffing and other resources to implement it will ensure longer lasting savings that could more than pay for themselves in the future.

General Plan Language Ideas

» The City/County shall develop a comprehensive strategy to reduce energy and water consumption in public facilities. The strategy shall include a management structure to oversee energy and water efficiency programs, quantitative objectives for reductions in energy and water consumption, specific programs to achieve objectives (including regular audits of facilities), a time schedule for implementation, identification of responsible departments, and sources of funding.

» The City/County shall evaluate the effectiveness of retrofitting all facilities with energy and water saving devices, including efficient indoor and outdoor lighting, improved heating, ventilation and air conditioning equipment, equipment controls, low flow plumbing fixtures, and energy and water efficient landscaping.

» All new and renovated City/County facilities shall use energy efficient designs that exceed current building and appliance standards. Lifecycle costing shall be used in major purchasing and construction decisions.

Implementation Ideas

» **Enter into a local government-utility partnership.** The California Public Utilities Commission (CPUC) oversees the spending of public goods charge energy efficiency funds that utilities collect from their customers. The CPUC has identified local government partnerships with utilities as a key element in its goal of reducing energy use statewide. Partnerships can focus first on improving the energy performance of municipal facilities, and then extend to the broader community.

» **Develop a comprehensive energy and water efficiency strategy.** Appoint an interdepartmental task force to develop the strategy, which should include specific objectives, implementation measures, time schedules, funding sources, and department responsibility.

» **Provide departments with information and incentives.** Track energy and water use by department and/or building (e.g., each fire station). This may require sub-metering. Post results regularly to maintain awareness and interest. Provide awards (monetary or other) to departments that meet conservation objectives. Departments could be charged for their individual energy and water use, providing additional incentives for reduction.

» **Assign overall responsibilities to a management-level employee.** One person should be responsible for overall development, management, and monitoring of the program. Appointing a full-time energy/water manager may be appropriate in a large jurisdiction. Smaller jurisdictions may combine these functions with other responsibilities, such as facilities management. With either option, make sure the person is given enough support to carry out objectives in a timely manner.

» **Monitor progress.** After efficient equipment or practices are implemented, monitor energy and water consumption to track benefits. Software programs that account for changes in weather are available to help track energy use. Monitoring energy and water consumption helps to identify problems and measure successes.

» **Inform decision-makers of progress.** Energy and water conservation programs will save the city/county money. In order to maintain a commitment to the program, council members and supervisors should be informed regularly of these savings and specific implementation programs

» **Educate employees.** Provide employees with new and useful information. Encourage employee involvement in the program, through task forces and suggestion boxes, so that educational materials are appropriate and effective. Educate employees about simple methods to avoid waste, such as turning off lights.

» **Perform regular audits and retrofit facilities.** All facilities should be audited for energy and water consumption on a regular basis. Retrofit buildings with a package of measures to maximize efficiency.

» **Incorporate energy and water expenses into purchasing decisions.** While inefficient equipment may be less expensive to purchase initially, the utility costs over the lifetime of the item may be significantly higher. Lifecycle costing incorporates this information into the procurement process (see strategy 5.1 Municipal Procurement).

» **Establish a fund or identify outside funding for efficiency improvements.** Efficiency improvements often require up front capital expenses. These expenses will eventually be recovered through lower utility bills, sometimes within a few years. A fund could be established, initially through bonds, general funds or other sources, to provide capital funding for efficiency projects. Alternatively, a source of outside funding, such as the Energy Commission and/or utility loan programs could provide capital funding for projects. All or part of the savings from utility bills resulting from the projects and utility rebates should be reinvested into the fund to continue developing savings into the future.

» **Speed up project authorization.** Approving capital expenses can often be a time consuming process in local government. In order to take advantage of deadlines for utility incentives and rebates, this process may need to be shortened.

» **Incorporate efficiency into new building design.** Energy and water efficiency improvements are usually less expensive and more effective when incorporated into the initial building design. Require buildings to exceed current minimum state standards for energy efficiency (see strategy B.1.2 Going Beyond State Minimum Energy Standards).

» **Implement a regular maintenance schedule.** Regular maintenance of equipment such as heating, ventilation, and air conditioning systems can improve efficiency.

- **Install an energy management system** (EMS). A computerized energy management system monitors energy use and controls heating, ventilation, and air conditioning (HVAC) equipment to maximize efficiency. Not all facilities are suited to EMSs. Some energy management systems can be integrated with other building functions such as security and fire safety. Budget for the cost of training staff.
- **Replace inefficient street lighting.** Street lighting usually represents a sizable portion of a jurisdiction's energy use. Consider installing induction lighting or solid state lighting (LEDs) and photocells that automatically turn lights on and off. Use induction or other efficient lighting fixtures in public parking lots and garages as well. Where electricity is unavailable, explore the availability of solar-powered street lighting. Consult with the Energy Commission, utilities, and the California Lighting Technology Center for information on the latest types of cost effective street and outdoor lighting.
- **Use pool covers, alternative pumping strategies, and energy efficient pool lighting.** Pool covers are a cost-effective way to reduce pool heating needs. Analyze the effectiveness of solar heating for public pools and install a system if feasible. Also consider alternative pool pumping strategies, including the use of two speed or variable speed pumping. Consider use of LED pool lighting when pools are operated in the evenings.
- **Install energy and water efficient landscaping.** Planting shade trees and other landscaping features can reduce heat gain in the summer. Water efficient landscaping will save water and energy along with reducing maintenance (see strategies B.1.7 Shade Trees and W.2.1 Water Efficient Landscaping).

Energy Savings

The City of Fairfield reduced energy needs by over 1.8 million kWhs, and over 182,000 therms per year and reduced peak demand by 274 kW, saving over $283,000 annually. A series of energy efficiency improvements funded with $2 million low interest loan from the Energy Commission, (including improvements to the existing HVAC system, controls and cogeneration system, lighting retrofits and recommendations for equipment maintenance) helped the city reduce utility bills and equipment maintenance costs. In addition, the city received rebates from PG&E for reducing peak energy loads.[1]

Contra Costa County implemented energy efficiency retrofits to eight buildings that reduced energy use by an average of 28 percent, saving 18,000 therms, 528,000 kilowatt-hours and $112,000 per year, which lowered building maintenance costs and improved indoor comfort for employees. The measures included replacing pneumatic controls with direct digital controls, controlling hot water pumping, and replacing variable inlet vanes on air-handling unit fans with variable frequency drives. The project was financed using two loans from the Energy Commission and county funds with a simple payback period of just over 6 years.[2]

A study of over 1,700 buildings in the United States, Canada, and Europe found that the median energy savings from retrofitting office buildings was 23 percent. The study also found that retrofit projects do not always achieve their maximum potential savings due to improper installation and calibration, lack of maintenance and inappropriate usage. The researchers concluded that energy management must be viewed not as an event but rather a process; one that incorporates both an understanding of proper building operation on the part of the facility manager and the long-term tracking of energy performance and specific indicators of operating problems.[3]

Environmental Benefits

Any reduction in electricity and natural gas use will result in fewer air pollutants entering the atmosphere. For example, using 1,000 kWh of electricity in California produces 690 pounds of greenhouse gases.[4] That amount of electricity could be saved in one year by replacing four 75-watt incandescent light bulbs with compact fluorescent lamps.[5]

Reducing energy consumption, particularly electricity use during the peak period, can help improve air quality by reducing pollutants from natural gas fired power plants.

Energy efficiency also reduces the environmental impacts of energy extraction and generation, including those caused by mining and transporting fuels and disposing of utility wastes. Water conservation helps to maintain fragile wildlife habitats, avoid construction of new dams and conveyance systems, and reduce wastewater.

Economics

The City of Oakland cut its annual energy costs by an estimated \$72,000 through energy retrofits at the Oakland Museum of California, and at several fire stations, city libraries, recreation centers, senior centers, parking garages, and tennis courts. These projects include the conversion of electric ovens to gas and retrofitting the central cooling plant at the museum, and installing energy efficient lamps and ballasts at several city facilities. The city recovered the initial cost of the retrofits (\$348,000) within five years.[6]

The City of San Carlos is saving \$80,000 a year in energy costs after retrofitting city hall with lighting, HVAC, variable air volume, air handler, and control upgrades. The city's maintenance costs have been reduced. The retrofits addressed indoor comfort problems (localized hot and cold spots) associated with the old heating and cooling system, which required the building to be heated and cooled at the same time. The Energy Commission loan covered 97 percent of the project cost with a simple payback period of 8.1 years.[7]

Programs In Operation

Alameda County has undertaken a municipal energy and water conservation program that has reduced its energy usage by one-third and saves taxpayers \$6.5 million annually. It includes a countywide lighting retrofit of three million square feet in 50 buildings; and a lighting retrofit, boiler plant renovation, water conservation, hot water and energy reclamation system for the laundry, new cooling water treatment system, and a heating and hot water system retrofit at the County jail. Water conservation measures include "Bay-Friendly" landscaping at the County Administration Building and low flow toilets, urinals, showers, faucets and irrigation at the jail. The jail also houses one of the largest photovoltaic arrays and fuel cell projects in the country. http://www.acgov.org/gsa/sustainability.htm

The **Ventura County Regional Energy Alliance** (VCREA) assisted in the development and implementation of lighting retrofit projects in six gymnasiums throughout Ventura County. Retrofitting metal halide lighting with new generation fluorescent and motion sensor activation created dramatic reductions in hours of use and improvements in light levels and quality. The completed projects reduced kWh by an average of 49 percent, with an annual electricity cost reductions of 48-55 percent. The projects averaged a 50 percent return on investment. http://www.vcenergy.org

Resources

The California Energy Commission's **Energy Partnership Program** offers cities and counties one-on-one technical assistance to improve energy efficiency in their facilities. The program also offers energy audits, review of proposals and designs, and equipment performance specification. http://www.energy.ca.gov/efficiency/partnership/index.html

The California Energy Commission's **Energy Efficiency Financing Program** provides ow-interest loans for the installation of energy-saving measures in schools, special districts, hospitals and other municipal buildings. http://www.energy.ca.gov/efficiency/financing

Most utilities offer rebates and design assistance for the installation of energy-conserving fixtures and equipment. Local governments can partner with investor-owned utilities to develop comprehensive municipal energy programs for residents and businesses. Check with your local utility for details.

The **California Department of Water Resources** (DWR) offers grants and loans for water conservation, agricultural water recycling, groundwater management, water quality and supply, and studies and activities to enhance local water supply reliability. http://www.grantsloans.water.ca.gov

Related Strategies

C.1.2	Community Energy District Financing
C.1.3	Cool Communities
C.2.1	Renewable Energy Resources
C.2.2	Distributed Generation

Endnotes

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MUNICIPAL FLEET EFFICIENCY

Local governments in California own and operate hundreds of thousands of vehicles. By increasing the fuel efficiency of individual vehicles, operating them more efficiently and improving overall fleet management, cities and counties can save significant amounts of energy and money while helping to address the risks associated with air pollution and climate change.

General Plan Language Ideas

» The City/County shall adopt a policy to purchase and/or lease the most fuel-efficient vehicles for the tasks they will perform.

» The City/County shall operate its vehicle fleet to improve fuel efficiency and reduce costs. Within one year, the Fleet Manager shall develop an energy conserving fleet management plan. The Council/Board shall provide the support necessary to implement the plan, which will than serve as a model for private fleet operators in the community.

Implementation Ideas

» **Put in place a management information system.** Document the impact of fleet activities by carefully inventorying all of your vehicles. Include the types of vehicles, how many of each type you have, and the kind and amount of fuel they use. By closely tracking maintenance schedules, fuel consumption, mileage and other information, the fleet manager can identify problems and develop solutions to reduce costs and fuel consumption.

» **Purchase fuel-efficient and appropriately-sized vehicles.** By analyzing the needs of their fleet, managers may be able to "down-size" it – substituting smaller vehicles for larger, less efficient ones when making new purchases. In all purchasing decisions, fuel efficiency should be a major criterion. Include minimum fuel efficiency in procurement specifications. Use life-cycle costing, including the cost of fuel, to fairly compare one vehicle purchase against another.

» **Assign vehicles appropriate to the task.** Often larger, more powerful vehicles are used when smaller, more efficient ones would perform the task just as effectively. The fleet manager should have the authority to analyze how vehicles are used and assign those that are the most appro-

San Mateo County's hybrid fleet.
Photo: San Mateo County Fleet and Facility Operations.

priate for the task. Using a powerful pickup truck for a trip that does not require hauling large or heavy items is not energy efficient.

» **Reduce the fleet size.** If some vehicles are used infrequently, consider reducing the overall fleet size. If more vehicles are used at certain times, mid-week versus Mondays and Fridays for example, consider ways to level out the peak to allow for reducing the number of vehicles. Reducing fleet size will lower maintenance and insurance costs and may reduce the practice of using vehicles for personal business.

» **Practice preventive maintenance.** Keeping tires properly inflated and performing regular tune-ups will improve fuel efficiency. In addition, regular preventive maintenance may avoid costly and time-consuming repairs.

» **Train maintenance staff.** Make sure maintenance staff is aware of practices to improve fuel economy. Staff should also recycle used oil, tires and batteries, and use non-toxic or low-toxic cleaning materials.

» **Inform drivers of fuel-efficient driving techniques.** Excessive idling, quick starts and speeding increase gasoline consumption. Make sure drivers are well versed in ways to cut fuel use.

» **Rental rates should reflect all costs.** If departments are charged for vehicle use, the rates should reflect the true cost of owning, operating, and replacing the vehicle. If charges are too low, departments receive the wrong price signals and fleets may not operate efficiently. For some trips, it may be less expensive and more energy efficient to use local transit or intercity trains.

» **Centralize fleet operations.** Many cities and counties have several departments that operate fleets independently and, as a result, inefficiently. By centralizing fleet operations under one management system, economies of scale can reduce costs, and fuel efficiency programs can be implemented more effectively.

» **Automate the fueling station.** Automated fueling stations can accurately keep track of how much fuel each vehicle uses. This can be used to track fuel efficiency, schedule preventive maintenance, and discourage excessive personal use of fleet vehicles.

Energy Savings

Fixing a car that is noticeably out of tune or has failed an emissions test can improve its gas mileage by an average of four percent, though results will vary based on the kind of repair and how well it is done. Fixing a serious maintenance problem, such as a faulty oxygen sensor, can improve mileage by as much as 40 percent.[1]

Keeping tires inflated to the proper pressure can improve gas mileage by around 3.3 percent. Under-inflated tires can lower gas mileage by 0.3 percent for every one pound per square inch (psi) drop in pressure of all four tires. Properly inflated tires are safer and last longer.[2]

Using the manufacturer's recommended grade of motor oil can improve gas mileage by one to two percent. For example, using 10W-30 motor oil in an engine designed to use 5W-30 can lower gas mileage by one to two percent. Using 5W-30 in an engine designed for 5W-20 can lower gas mileage by 1-1.5 percent. Look for motor oil that says "Energy Conserving" on the API performance symbol to be sure it contains friction-reducing additives.[3]

Aggressive driving wastes gas. Speeding, rapid acceleration and quick braking can lower gas mileage by 33 percent at highway speeds and by five percent around town.[4]

While each vehicle reaches its optimal fuel economy at a different speed (or range of speeds), gas mileage usually decreases rapidly at speeds above 60 mph.[5]

Combining errands into one trip saves time and money. Several short trips taken from a cold start can use twice as much fuel as a longer multipurpose trip covering the same distance when the engine is warm. Trip planning ensures that traveling is done when the engine is warmed-up and efficient and can reduce the distance traveled.[6]

The amount of energy saved from downsizing a fleet will depend upon the efficiency of the existing fleet and the rate that vehicles are replaced. For example, replacing 20 percent of the fleet with vehicles that average 30 mpg instead of 25 mpg would reduce overall fuel consumption by four percent, assuming that the new vehicles are driven the same amount as the vehicles they replaced.

Environmental Benefits

Reducing fuel consumption through improving efficiency directly reduces carbon dioxide and other air pollutant emissions. For every gallon of gasoline saved, about 22 fewer pounds of carbon dioxide (CO_2) are emitted.[7]

Economics

Reducing fuel consumption in city/county fleets results in direct economic savings. Reducing fuel consumption by

Plug-in hybrids and charging stations.
Photo: Sonoma County Fleet and Facility Operations.

just 10 percent through regular maintenance, proper tire inflation, and down-sizing a portion of the fleet, would reduce fuel costs by a comparable percentage. In addition, regular maintenance to improve fuel efficiency can eliminate costly repairs. In most cases, the costs of providing regular maintenance can be absorbed in the existing budget and will be offset by avoided repair work.

The cost of computer software for an information management system will depend upon a department's needs and its computer hardware. Public domain software is available. Magazines aimed at fleet managers often list available software.

Programs In Operation

On Earth Day, 1993, **Denver, Colorado** created the first Green Fleets program in the nation. The Green Fleets executive order requires the managers of both Denver's city vehicles and the fleet at the Denver International Airport to purchase the most cost-effective and lowest emission vehicles possible, and to include fuel-efficiency standards in their procurement specifications. The Green Fleets review process also includes "right-sizing" fleets by reducing vehicle size and eliminating old and underused vehicles. The effectiveness of the program is measured by fleet energy use and CO_2 emissions. In 2008, alternatively fueled or powered vehicles made up 43 percent of the city's total fleet of 3,533 vehicles. Switching to more fuel-efficient vehicles, as well as ones that use cleaner biofuels, is helping Denver to reach its goal to reduce per-capital greenhouse gas emissions by 10 percent below 1990 levels by 2012. http://www.greenfleets.org

In 2007, the City of **San Jose** adopted a Green Fleet Policy to make every effort to purchase and use the lowest emission vehicle or equipment item possible, while taking into account the vehicle's life-cycle costs and the ability to support city operations and services. Through implementation of this policy, the city sought to decrease total vehicle emissions by 25 percent by fiscal year 2012-13, using 2002-03 as a baseline year. San Jose's Green Fleet Strategies include:

» Optimizing fleet size.

» Decreasing vehicle emissions.

» Reducing vehicle size.

» Increasing use of alternate fuel vehicles and equipment.

» Implementing best practices to minimize vehicle miles traveled (VMT).

http://sanjoseca.gov/esd/PDFs/GreenFleetPolicy_091707.pdf

The City of **Berkeley** partnered with City CarShare, a San Francisco Bay Area carsharing organization, to replace municipal fleet vehicles with carsharing vehicles. This has allowed the city to quickly transition to using new, super fuel-efficient hybrid Toyota Prius vehicles without additional costs. http://www.mayorsinnovation.org/pdf/park_june05.pdf

City CarShare vehicles used by City of Berkeley staff on weekdays, and by the public on evenings and weekends.
Photo: Cambridge Systematics, Inc.

Resources

The Sierra Club developed the web site coolfleets.com to help commercial, government and municipal fleets to model vehicle alternatives and to better understand carbon outputs and lifecycle costs. Car and truck fleets are significant contributors to greenhouse gases, and the selection of vehicles that are more fuel efficient can not only reduce CO_2 but can also lower the total cost of fleet operations. http://coolfleets.com

The Puget Sound Clean Air Agency and Puget Sound Clean Cities Coalition have developed a comprehensive step by step guide to greening public and private vehicle fleets. Their web site includes a process for developing a green fleets plan and an emissions calculator. http://psgreenfleets.org/reduction-strategies/develop-a-plan

The U.S. Department of Energy Alternative Fuels and Advanced Vehicles Data Center (AFDC, formerly known as the Alternative Fuels Data Center) provides a wide range of information and resources about using alternative fuels. It also explains other petroleum reduction options such as advanced vehicles, fuel blends, idle reduction, and fuel economy. The site is sponsored by the U.S. Department of Energy's Clean Cities initiative. http://www.afdc.energy.gov/afdc

Endnotes

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APPENDIX A

EMISSIONS FACTORS

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GREENHOUSE GAS EMISSIONS FACTORS

Summary Emissions Factors

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In the Energy Aware Planning Guide, the emissions factor for greenhouse gas emissions is based on carbon dioxide equivalents (CO_2e).

Further Guidance on Estimating GHG from Projects

Estimating the actual GHG reductions is complicated because different sources of electricity release different quantities of emissions and since California's power comes from an inter-connected electricity system, it is difficult to tell which emissions are being avoided. Further guidance is available from these sources:

The California Air Resources Board provides standards applicable to the estimation of projects GHG emissions. Resources include:

- » For rules pertaining to electricity provider GHG reporting see: http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep-guid/08_ElectricitySec.pdf.
- » For rules relating to co-generation facilities see: http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep-guid/09_Cogen.pdf.
- » For rules related to stationary combustion sources see: http://www.arb.ca.gov/cc/reporting/ghg-rep/ghg-rep-guid/12_GSCs.pdf.

Various types of GHGs may be reduced depending upon the type of project funded; estimates of reduced fugitive methane emissions, methane captured and converted to carbon dioxide, reductions in nitrous oxide, sulfur hexafloride, and various perfluorocarbons (PFCs) and hydrofluorocarbons (HFCs) could be compiled for each project. When estimating GHG emission reductions from these types of projects, protocols at the following organizations may be useful:

Table 1: Summary Emissions Factors for Energy Use in California

Type of Energy Reduced	C02e Emissions Factor	Units	Data Type/Source:
Electricity	690	lbs CO_2 / MWh	California – specific data from updated macroeconomic analysis of Climate strategies presented in the March 2006 climate action team report Final report Prepared by: Economics subgroup Climate action team October 15, 2007
Natural Gas	11.68	lbs CO_2 / therm	National Average from the Environmental Protection Agency. AP42 Natural Gas Source Emissions Factor, July 1998.
Transportation Energy Use – Per Gallon of Fuel			
Gasoline	19.4	lbs CO_2 / gallon	Environmental Protection Agency. EPA420-F-05-001 February 2005.
Diesel	22.2	lbs CO_2 / gallon	Environmental Protection Agency. EPA420-F-05-001 February 2005.
Transportation Energy Use – Per Mile			
Fuel use / vehicle	12,000 miles per year and 21 miles per gallon for average passenger vehicle in California	Emission Factors (EMFAC) Model 2007 Version 2.3	
Water Pumping and Treatment			
Northern California	0.00395	kWh / gallon	California Energy Commission. Refining Estimates of Water Related Energy Use in California, December 2006.
Southern California (south of Tehachapi Mountains)	0.0127	kWh / gallon	California Energy Commission. Refining Estimates of Water Related Energy Use in California, December 2006.

» The Climate Action Reserve: http://www.climateactionreserve.org/how-it-works/protocols.

» The Climate Registry: http://www.theclimateregistry.org/resources/protocols.

» Climate Leaders Program: http://www.epa.gov/stateply/resources/index.html.

» USEPA GHG Reporting: http://www.epa.gov/climatechange/emissions/ghgrulemaking.html.

» ANSI ISO 14064-2 (2006): https://www.ansica.org/wwwversion2/outside/GHGgeneral.asp?menuID=200.

Helpful Conversion Factors

Powers of Ten

» 10 deka (da).

» 10^3 kilo (k).

» 10^6 mega (M).

» 10^9 giga (G).

» 10^12 tera (T).

Volume

- 1 cubic meter (m3) = 1000 liters = 264.2 U.S. gallons = 35.31 cubic feet (ft3).
- Example: to find the number of gallons in a cubic kilometer of water:
- 1 km3 X 10^9 m3 / km3 X 264 gal/m3 = 264 x 10^9 gallons.

Mass and Density

- 1 kilogram (kg) = 2.205 pounds.
- 1 metric ton (tonne or MT) = 10^3 kg.
- 1 pound (lb) = 463.6 grams (g).

Energy

- 1 kilowatt-hour (kWh) = 3.6 x 10^6 J = 3412 Btu.
- 1 Calorie = 1 kiloCalorie (Kcal) = 10^3 cal.
- 1 therm = 10^5 Btu.

Power

- 1 watt (W) = 1 joule/second = 3.6 kJ/hour = 31.5 MJ/year.
- 1 horsepower (hp) = 0.764 kilowatts (kW).

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APPENDIX B

AHWAHNEE PRINCIPLES

ENERGY AWARE PLANNING GUIDE

THE AHWAHNEE PRINCIPLES

The Ahwahnee principles are a simple, concise set of principles intended to guide local governments in the development of sustainable, resource-efficient communities. The Ahwahnee Principles for Resource-Efficient Communities, Water, and Climate Change are listed below.

Ahwahnee Principles for Resource Efficient Communities

Preamble

Existing patterns of urban and suburban development seriously impair our quality of life. The symptoms are: more congestion and air pollution resulting from our increased dependence on automobiles, the loss of precious open space, the need for costly improvements to roads and public services, the inequitable distribution of economic resources, and the loss of a sense of community. By drawing upon the best from the past and the present, we can plan communities that will more successfully serve the needs of those who live and work within them. Such planning should adhere to certain fundamental principles.

Community Principles

» All planning should be in the form of complete and integrated communities containing housing, shops, work places, schools, parks and civic facilities essential to the daily life of the residents.

» Community size should be designed so that housing, jobs, daily needs and other activities are within easy walking distance of each other.

» As many activities as possible should be located within easy walking distance of transit stops.

» A community should contain a diversity of housing types to enable citizens from a wide range of economic levels and age groups to live within its boundaries.

» Businesses within the community should provide a range of job types for the community's residents.

» The location and character of the community should be consistent with a larger transit network.

» The community should have a center focus that combines commercial, civic, cultural and recreational uses.

» The community should contain an ample supply of specialized open space in the form of squares, greens and parks whose frequent use is encouraged through placement and design.

» Public spaces should be designed to encourage the attention and presence of people at all hours of the day and night.

» Each community or cluster of communities should have a well-defined edge, such as agricultural greenbelts or wildlife corridors, permanently protected from development.

» Streets, pedestrian paths and bike paths should contribute to a system of fully-connected and interesting routes to all destinations. Their design should encourage pedestrian and bicycle use by being small and spatially defined by buildings, trees and lighting; and by discouraging high speed traffic.

» Wherever possible, the natural terrain, drainage and vegetation of the community should be preserved with superior examples contained within parks or greenbelts.

» The community design should help conserve resources and minimize waste.

» Communities should provide for the efficient use of water through the use of natural drainage, drought tolerant landscaping and recycling.

» The street orientation, the placement of buildings and the use of shading should contribute to the energy efficiency of the community.

Regional Principles

» The regional land-use planning structure should be integrated within a larger transportation network built around transit rather than freeways.

» Regions should be bounded by and provide a continuous system of greenbelt/wildlife corridors to be determined by natural conditions.

» Regional institutions and services (government, stadiums, museums, etc.) should be located in the urban core.

» Materials and methods of construction should be specific to the region, exhibiting a continuity of history and culture and compatibility with the climate to encourage the development of local character and community identity.

Implementation Principles

» The general plan should be updated to incorporate the above principles.

» Rather than allowing developer-initiated, piecemeal development, local governments should take charge of the planning process. General plans should designate where new growth, infill or redevelopment will be allowed to occur.

» Prior to any development, a specific plan should be prepared based on these planning principles.

» Plans should be developed through an open process and participants in the process should be provided visual models of all planning proposals.

Authors: Peter Calthorpe, Michael Corbett, Andres Duany, Elizabeth Moule, Elizabeth Plater-Zyberk, and Stefanos Polyzoides. Editor: Peter Katz, Judy Corbett, and Steve Weissman. Adopted in 1991.

The Ahwahnee Water Principles for Resource-Efficient Land Use

Preamble

Cities and counties are facing major challenges with water contamination, storm water runoff, flood damage liability, and concerns about whether there will be enough reliable water for current residents as well as for new development. These issues impact city and county budgets and taxpayers. Fortunately there are a number of stewardship actions that cities and counties can take that reduce costs and improve the reliability and quality of our water resources.

The Water Principles below complement the Ahwahnee Principles for Resource-Efficient Communities that were developed in 1991. Many cities and counties are already using them to improve the vitality and prosperity of their communities.

Community Principles

» Community design should be compact, mixed use, walkable and transit-oriented so that automobile-generated urban runoff pollutants are minimized and the open lands that absorb water are preserved to the maximum extent possible. (See the Ahwahnee Principles for Resource-Efficient Communities)

» Natural resources such as wetlands, flood plains, recharge zones, riparian areas, open space, and native habitats should be identified, preserved and restored as valued assets for flood protection, water quality improvement, groundwater recharge, habitat, and overall long-term water resource sustainability.

» Water holding areas such as creek beds, recessed athletic fields, ponds, cisterns, and other features that serve to recharge groundwater, reduce runoff, improve water quality and decrease flooding should be incorporated into the urban landscape.

» All aspects of landscaping from the selection of plants to soil preparation and the installation of irrigation systems should be designed to reduce water demand, retain runoff, decrease flooding, and recharge groundwater.

» Permeable surfaces should be used for hardscape. Impervious surfaces such as driveways, streets, and parking lots should be minimized so that land is available to absorb storm water, reduce polluted urban runoff, recharge groundwater and reduce flooding.

» Dual plumbing that allows graywater from showers, sinks and washers to be reused for landscape irrigation should be included in the infrastructure of new development.

» Community design should maximize the use of recycled water for appropriate applications including outdoor irrigation, toilet flushing, and commercial and industrial processes. Purple pipe should be installed in all new construction and remodeled buildings in anticipation of the future availability of recycled water.

» Urban water conservation technologies such as low-flow toilets, efficient clothes washers, and more efficient water-using industrial equipment should be incorporated in all new construction and retrofitted in remodeled buildings.

» Ground water treatment and brackish water desalination should be pursued when necessary to maximize locally available, drought-proof water supplies.

Implementation Principles

» Water supply agencies should be consulted early in the land use decision-making process regarding technology, demographics and growth projections.

» City and county officials, the watershed council, LAFCO, special districts and other stakeholders sharing watersheds should collaborate to take advantage of the benefits and synergies of water resource planning at a watershed level.

» The best, multi-benefit and integrated strategies and projects should be identified and implemented before less integrated proposals, unless urgency demands otherwise.

» From start to finish, projects and programs should involve the public, build relationships, and increase the sharing of and access to information.

» Plans, programs, projects and policies should be monitored and evaluated to determine if the expected results are achieved and to improve future practices.

Authors: Celeste Cantu, Martha Davis, Jennifer Hosterman, Susan Lien Longville, Jeff Loux, John Lowrie, Jonas Minton, Mary Nichols, Virginia Porter, Al Wanger, Robert Wilkinson, Kevin Wolf. Editor: Judy Corbett. Adopted in 2005.

The Ahwahnee Principles for Climate Change

Preamble

Climate change is not just another environmental issue. Concentrations of human induced greenhouse gases (GHG) in the atmosphere have already reached unprecedented levels and are causing well documented adverse changes to our planet's physical and biological systems.

We must act decisively to reverse this trend, to lessen the potentially devastating environmental, economic and social impacts that could result.

At the same time, we must predict and prepare for, and adapt to, the unavoidable climatic changes that will likely occur due to the high concentration of greenhouse gas pollutants that are already in the atmosphere.

Community Principles

» Climate Action Plans for mitigating GHG emissions should be put in place by local governments; these will include inventories, targets for reduction, implementing strategies, timelines and a system for reporting annual progress. Plans should be incorporated into general plans either as a separate element that has influence over a broad range of activities or by incorporation into each of the traditional general plan elements.

» Emissions related to personal auto use are often the largest single source of greenhouse gas pollution, therefore, addressing this source should be central to a Climate Action Plan and a priority for early implementation. Infill development should be recognized as the primary location of new construction, however all new development, wherever it may occur, should be guided by the Ahwahnee Principles for Resource Efficient Communities. Development built according to these principles will display a compact mixed-use pattern that supports walking, biking and transit, and protects open space and agricultural land. Development plans should be coordinated with a regional plan, where one exists. This kind of development can reduce vehicle miles traveled (VMT) and CO2 emissions by 20 percent to 40 percent per capita (Growing Cooler, Urban Land Institute, 2008).

» The Electricity and Commercial/ Residential sector is likely the second largest source of community GHG emissions and an important target for reduction. Thus, energy conservation programs, energy efficiency and the use of a diverse array of clean alternative energy sources should also be central to the community Climate Action Plan and a priority for timely adoption. Applied to new and existing development, green building ordinances, energy conservation retrofit measures, energy efficiency standards for new buildings, and incentives/disincentives to reduce average square footage of new houses are among the measures that can be adopted (www.energy.ca.gov/energy_aware_guide).

» Climate Action Plans should also include strong water efficiency standards, increased water conservation and water recycling strategies guided by the Ahwahnee Water Principles.

» A Climate Action Plan should include measures that will help the community to adapt to the unavoidable impacts of climate change. This will involve planning for rising sea levels, shrinking water supplies, rising temperatures, food shortages and other challenges predicted to occur in the region.

» Local governments should lead by example in reducing their own carbon footprint by enacting and implementing policies to reduce GHG emissions from their municipal operations while preparing for unavoidable climate change impacts.

» Climate Action Plans should be developed through an open process that includes diverse members of the community and public health professionals. The process should include public outreach strategies and assure that the positive and negative impacts of reducing emissions are borne equally by all.

Regional Principles

» Each region should develop and adopt, with its cities and counties, a blueprint for growth that achieves regional GHG emissions reduction targets. Blueprints should form the basis for city-centered growth, infill development, open space protection, transit-oriented development and multijurisdictional corridor development. They should reflect differences among their communities.

» Regional Transportation Plans and major regional transportation projects should be consistent with the regional blueprint.

» Projects consistent with the blueprint that support infill development and reduce single occupant vehicle trips should be given priority in funding and a streamlined implementation process.

» Efforts should be made by regions to vocally support such projects and defend them against opposition.

- Regional Housing Needs Assessments that recognize the differences between regions and between communities should be coordinated with and reflect Climate Action Plans and other mechanisms for GHG emission reductions. Regional transportation, land use, and GHG reduction plans must recognize differences between regions and between communities.

Implementation Strategy

- All General Plans and Climate Action Plans should be made consistent with the principles contained in Regional Blueprint Plans and Regional Transportation Plans.
- General Plans and environmental review processes should be integrated with city and county Climate Action Plans to include climate change mitigation and adaptation measures and adoption procedures.
- Zoning codes should be modified to be consistent with the General Plan to ensure implementation of the integrated General Plan/Climate Action Plan. Performance and form-based codes should be used to achieve the specified outcome.
- City and county policies should be made consistent with the goals of the community Climate Action Plan (such as flexible work schedules, car-sharing and bike-sharing programs, etc.)
- Monitoring and measurement of progress made in meeting both goals and targets set forth in the Climate Action Plan should be conducted regularly with results reported to the community.
- When appropriate, communities should form joint powers authorities to jointly implement their climate action plans through developing sustainability corridors between two or more jurisdictions.
- Cities and counties should coordinate with nearby jurisdictions and the regional government to share computer tools and other resources, and avoid duplicative efforts.

Authors: Larry Allen, San Luis Obispo County Air Pollution Control District; Geoff Anderson, Smart Growth America; Gary Cook, ICLEI; Councilmember Jennifer Hosterman, City of Pleasanton; Dr. Richard J.Jackson, MD, MPH; Mayor Jake Mackenzie, City of Rohnert Park; Jim Murley, Joint Center for Environmental and Urban Problems, Florida Atlantic University; Councilmember Pam O'Connor, City of Santa Monica; Geof Syphers, Codding Enterprises; Dr. Robert Wilkinson, Water Policy Program, UC Santa Barbara; Steve Winkelman, Transportation Program Center for Clean Air Policy. Editors: Gregg Albright, California State Department of Transportation; Councilmember Jon Harrison, City of Redlands; Judy Corbett and Kate Wright, Local Government Commission.

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